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ABSTRACT

This booklet introduces a new and general approach to the scientific method for everyone. Teaching the scientific method to all students allows them to develop their own talents and is necessary to prevent the loss of jobs. Many job areas that require scientific methodology are listed. Harmful results that may occur because of not teaching the scientific method are also discussed. Chapters include: (1) "Explanation of the General Pattern of the Scientific Method"; (2) "The Advantages of Teaching and Learning the Scientific Method"; (3) "Management Science and Scientific Management"; (4) "Ideas and Recommendations for Teaching the Scientific Method"; (5) "More Information about "The Scientific Method""; (6) "Misunderstandings, Misinterpretations and Controversies Concerning "The Scientific Method""; and (7) "Conclusion". (YDS)

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THE GOLDEN FORMULA FOR THE RELEASE OF HUMAN POTENTIAL

Edmund's Idea and Research Report
on

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD

ED 445 919

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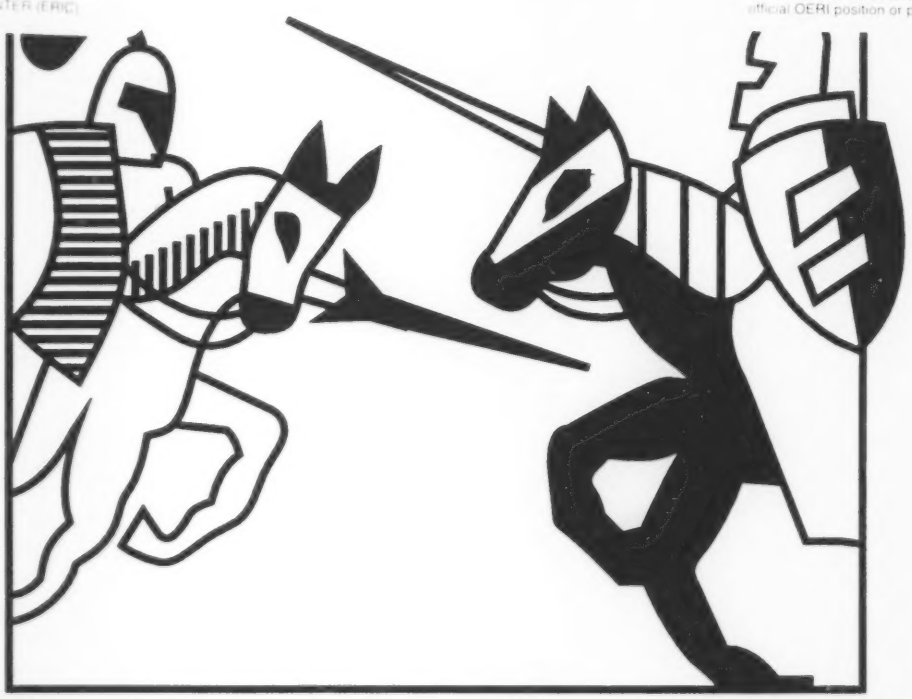

A Challenge to America to Recognize and Teach THE BASIC METHOD BY WHICH WE REFINE, EXTEND, AND APPLY KNOWLEDGE IN ALL FIELDS

SE 060 127

Compiled and Written by
Norman W. Edmund
Retired Founder of Edmund Scientific Company

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THE GOLDEN FORMULA FOR THE GOLDEN AGE OF KNOWLEDGE

Norman W. Edmund

Retired Founder of Edmund Scientific Company
Researching The General Pattern of The Scientific Method,
Discovery, Problem Solving, Innovation, and Creativity

My greeting to you is a challenge!

We all want advancement, prosperity, jobs, health, and a better education—not only for ourselves but for our children, grandchildren, and country.

A major barrier to attaining these goals is the result of one of the most unusual situations ever to develop in the educational field. This has been allowed to continue for over forty years, without challenges or general discussions. Therefore, few people are familiar with the basic method by which we refine, extend, and apply knowledge in all fields—best called,

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

It has also resulted in billions of dollars of taxpayer educational dollars being wasted — to say nothing of human potential!

The research presented in this booklet offers the opportunity and shows the way to correct this situation.

My challenge is this:

- Read about the many advantages to you and your children that have been missed because "the greatest discovery of science" has not been adequately taught.
- Challenge my claims and, if you agree, then challenge others as to why SM-14 should not be standardized and taught.
- Start to use SM-14 yourself. Do anything you can to familiarize others with the method. It is vitally needed in this age of knowledge.

Yours for a better world,

Norman W. Edmund

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Essay Style of this Report—"We think in ideas!"
In order to make for easier reading, the style used to present ideas and information is a one-page condensed essay. With this method, the ideas are more easily and quickly accessible—you can skip and skim, copy the pages, file, and discuss the ideas with others. (Some repetition occurs due to the emphasis of points that are especially important to understand.)

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Scientific Management Overlooked

During the first three years of research, my main interest was to introduce SM-14 to the educational field. It was obvious that SM-14 also applied to planning and management, but I concentrated on books which related to science, psychology, philosophy, education, and creativity. This resulted in the first edition of this report (November 1992). While composing this second edition, it seemed appropriate to include a page or two (which eventually turned in to an entire chapter) on the close relationship and importance of SM-14 to Scientific Management.

This should be of great interest to the commercial field as well as the educational field for educating our future managers. Today, there is a Total Quality Management movement in the educational field to improve the way we educate students. This movement should utilize SM-14.

I'm not embarrassed about this oversight. As stated on Page 44, no one need be embarrassed about misunderstanding "The Scientific Method," for it is a complex subject. Unless you study and research all angles you do not know its many applications and its great value. While much has been written about it, there has not been a clear presentation of its plausible and probable nature and its many practical uses. This Idea & Research Report attempts to correct this and to support that "The Scientific Method" is "***the greatest discovery of science.***"

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I am delighted to announce an endorsement of SM-14!
Dr. W.I.B. Beveridge is the author of the famous and oft-cited books, *The Art of Scientific Investigation* (1957) and *Seeds of Discovery* (1980). He was one of the first to challenge Sir Karl Popper's concept that there was no logic to *context of discovery.*

After reading my two booklets, he wrote: ***Your proposal to teach SM-14 not only to young scientists but also as part of general education is excellent and I wish you success.***

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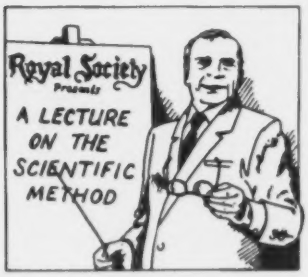
CHAPTER I
EXPLANATION OF THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

INTRODUCTION TO THE GOLDEN FORMULA

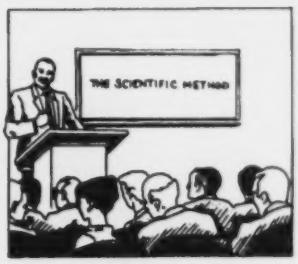


Ever since the *Age of Authoritarianism* ended and the *Golden Age of Science* began, a body of knowledge has been developing which helps us refine, extend, and apply knowledge in all fields. We usually accomplish this through following a formula for problem origination, prevention, solution, and challenge of solution—truly a *Golden Formula*!

This *Golden Formula* has been known by many names, the most common being "The Scientific Method." It is **not,** however, just a method for scientists. It is a formula (or guide) for use by everyone! It is used unconsciously or by following a guide. From its use flows our scientific, technological, social, and economic development; creation of jobs; wealth and well-being.

Our students (young and old) cannot always understand the deep philosophical theories and technical concepts of our intellectual community in their quest for the "truth" about "The Scientific Method." We need a simple guide for the *Golden Formula* in easy-to-understand terminology that can be taught to the typical student by the typical teacher. It should be nationally standardized for all grades and taught across the curricula. This will provide a golden key to a sound and practical base for teaching thinking skills, methods, processes, science, technology, social sciences, management, etc. It will also provide an improved basis for testing student accomplishment.

Pure gold is hard to obtain and impossible to formulate. So it is with a "pure" explanation of the *Golden Formula.* Philosophers, scientists, educators, and leaders of many other domains have been exploring, debating, and reformulating this "method" for centuries. Even today, there are some who continue to deny the existence of such a guide. During my four years of research, more than a thousand pieces of literature were "mined," with a result of cataloging over 300 different formulas or versions for the *Golden Formula.* Though known by many names, a single basic, flexible pattern of ingredients emerged consistently throughout.



Of all of the formulas studied, the one which I believe comes closest to fitting our requirements for a standard *Golden Formula* was presented by Dr. K. B. M. Crooks (1905-1959) at the December 1958 meeting of the American Association for the Advancement of Science, in his paper called *Suggestions for Teaching The Scientific Method.* Dr. Crooks' formula has been updated to reflect the current Age of Knowledge by adding several ingredients and changing a few terms. A less controversial and more descriptive name of this golden formula is THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

SM-14 is the formula recommended. However, always consider it to mean SM-14 (or similar), as an official standardization panel may decide to alter it slightly.

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THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

THE BASIC METHOD BY WHICH WE REFINE, EXTEND, AND APPLY KNOWLEDGE IN ALL FIELDS THROUGH PROBLEM ORIGINATION, PREVENTION, SOLUTION, AND CHALLENGE OF SOLUTION. A GENERAL METHOD FOR USE BY EVERYONE—NOT JUST SCIENTISTS!

CURIOUS OBSERVATION

THE PROBLEM

GOALS PLANNING

SEARCH EXPLORE

ALTERNATIVE SOLUTIONS

EVALUATE EVIDENCE

GUESS (HYPOTHESIS)

INGREDIENTS OF SM-14

PART I

Origination to Hypothesis

1. Curious Observation
2. Is There A Problem?
3. Goals and Planning
4. Search, Explore, and Gather the Evidence
5. Generate Creative and Logical Alternative Solutions
6. Evaluate the Evidence
7. Make the Educated Guess (Hypothesis)

PART II

Challenge to Suspend Judgment

8. Challenge the Hypothesis
9. Reach a Conclusion
10. Suspend Judgment

PART III

11. Take Action

PART IV

Supporting Ingredients

12. Motivation and Sensitivity
13. Personal Attributes
14. Thinking Skills, Methods, and Processes

CHALLENGE HYPOTHESIS

REACH CONCLUSION

SUSPEND JUDGMENT

TAKE ACTION

MOTIVATION SENSITIVITY

PERSONAL ATTRIBUTES

THINKING PROCESSES

SM-14 IS THE MISSING DIMENSION IN EDUCATION

SM-14 provides one method suitable to become a national standard, to replace the teaching of:

- No method (guide) on how to refine, extend, and apply knowledge.
- Hundreds of guides called by various names—all basically derived from or part of "The Scientific Method" (see page 34).
- Terminology in other guides that is too long, not complete, and harder to learn than the simple (but complete) terminology used in SM-14.

PRACTICAL HELP WITH EVERYDAY PROBLEMS & DECISIONS

The full SM-14 formula is usually for use with complex, ill-structured problems that require research and study. However, problems come in a variety of complexities, some requiring a shortened formula.

SM-7 (FOR INTERMEDIATE-TYPE PROBLEMS AND DECISIONS)

— Can also be used as a preliminary or introduction to teaching the full SM-14 formula —

INGREDIENT SM-7	INGREDIENT SM-14	Short Name — SM-7 Short Scientific Method—7 Ingredients, Labeled A to G
A	1	***Curious Observation***. Find a problem.
B	2	***Is There A Problem?*** Consider purpose, define problem, and estimate requirements to solve problem, all in relation to the time available.
C	4	***Search—Explore***. Review and reflect mentally for solutions. If important enough and time is available, gather evidence as described on Pages 11 & 33 of the Student Booklet. Your *intuitive base* may supply you with answers.
D	5	***Alternative Solutions***. Be sure to devote enough time to generating creative and logical alternative solutions. See Pages 13, 34-37 of the Student Booklet.
E	6	***Evaluate***. If it is an important problem or decision, you must evaluate, rate, and challenge all possible solutions. Again, memories of past experiences in your intuition base may be of help
F	7	***Guess—Hypothesis***. Time may force you to settle for "good enough."
G	11	***Take Action!***

SHORT KEYWORD TERMINOLOGY FOR INGREDIENTS (FOR EASIER RETENTION)

One-Word Abbreviations

1. Curiosity
2. Problem
3. Planning
4. Search
5. Solutions
6. Evaluate
7. Hypothesis
8. Challenge
9. Conclusion
10. Suspend
11. Action
12. Motivation
13. Attributes
14. Thinking

Two-Word Abbreviations

1. Curious Observation
2. The Problem
3. Goals—Planning
4. Search—Explore
5. Alternative Solutions
6. Evaluate Evidence
7. Guess—Hypothesis
8. Challenge Hypothesis
9. Reach Conclusion
10. Suspend Judgment
11. Take Action
12. Motivation—Sensitivity
13. Personal Attributes
14. Thinking—Processes

For an explanation of the SM-14 ingredients, read my Student Booklet: THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

It contains a page on each ingredient, along with:

- General description and principles for its utilization.
- Some thinking skills and creative, logical, and technical methods for use under the ingredients.
- Pages showing an example of each ingredient's application to choosing a career as well as two historical uses.

Many supplemental pages offer information to help you achieve your goals.

Dr. James K. Feibleman (Scientific Method, 1972) states: *"It has often been said that the greatest discovery in science was the discovery of the scientific method of discovery."*

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WHY DO WE THINK?

We have to think to survive! Life is really just one problem after another (or, as we should think of it, one opportunity after another). Thinking and problem-solving skills are essential parts of a productive and satisfying life.

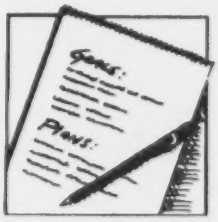
THE PROBLEM

John Dewey, in *How We Think* (1933)
"We may recapitulate by saying that the origin of thinking is some perplexity, confusion, or doubt. Thinking is not a case of spontaneous combustion; it does not occur just on 'general principles.' There is something that occasions and evokes it. General appeals to a child (or to a grown-up) to think, irrespective of the existence in his own experience of some difficulty that troubles him and disturbs his equilibrium, are as futile as advice to lift himself by his bootstraps."

REACH CONCLUSION

Charles R. Foster, in *Psychology for Life Today* (1966, 16th Printing)
"In psychology the term *thinking* is usually applied to that type of mental process which we identify as problem solving. There are, however, a number of kinds of mental activity which are sometimes referred to as thinking. There is a general 'stream of consciousness' of which we are aware during all or most all of our waking movements. A succession of ideas, images, reveries, and associations streams through the mind, and we are aware, if we stop to contemplate it, of this activity of ours. In most present-day psychology, however, when the subject of thinking is under consideration, the phase of it which has to do with reasoning or problem solving is of chief concern. Hence, in this chapter we are confining our discussion to the psychology of *thinking as problem solving*. We are omitting any consideration of thinking as revery, or as daydreaming in the usual sense of the term—we are thinking mainly of what occurs, in our mental processes as we deal with the everyday problems of life."

An Important Point to Realize—Efficient Problem Solving Requires SM-14!
The above quotes indicate that most of our thinking (at least, our important thinking) is used for problem solving. However, when the term "problem solving" is used, it should be understood to mean problem origination, prevention, solution, and challenge of solution.



GOALS & PLANNING

The base for sound reasoning is THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14). Thus, teaching the SM-14 (or similar) method, guide, or formula, and teaching how to use it, should be one of the primary objectives of education.

ESTIMATED NUMBER OF YEARS IT TOOK FOR KNOWLEDGE TO DOUBLE (SINCE 1750)

1750-1900=150 YRS 1900-1950=60 YRS 1950-1960=10YRS SINCE 1960=EVERY 5 YEARS (EVEN FASTER IN RECENT YEARS)

PROJECTION!

KNOWLEDGE WILL DOUBLE EVERY 73 DAYS BY THE YEAR 2020*

We must think and plan accordingly now!

A logical conclusion is that we must teach SM-14 and methods, as well as subject matter.

* Projection stated in an article published by the American Association of State Colleges and Universities

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THINKING IS AIDED BY A METHOD OR GUIDE

SM-14 serves the important function of guiding our thinking.

"Method consists of a set of operations by which the machinery of thought is set going and kept at work on any subject." **John Dewey, How We Think (1933).**

Here are just a few of the advantages of having a method for problem origination, prevention, solution, and challenge of solution, as suggested by various authors:

1. Organizes our thoughts
2. Clarifies our thoughts
3. Ends aimless wandering
4. Helps ideas gather shape
5. Doesn't have to be reinvented
6. Routes to new knowledge
7. Increases self-confidence
8. Aids specific transfer of training
9. Keeps us pointed in the right direction
10. Avoids relying only on intuition
11. Doesn't have to be learned by osmosis
12. Gives direction on future problems
13. Trains for change and innovation
14. Encourages conceptual thinking

Karl Pearson, The Grammar of Science (1911)

"Personally I have no recollection of at least 90 percent of the facts that were taught to me at school, but the notions of method which I derived from my instructor in Greek grammar (the contents of which I have long since forgotten) remain in my mind as the really valuable part of my school equipment for life."

Isaac Asimov, introduction to Saul and Newman's book, Science Fare (1986)

"In fact, it is to children that the scientific method should be taught, for it must be instilled early. If a child grows up without this mental discipline and becomes an adult without having learned how to think in a systematic way, it may be too late to begin then."

David Perkins, Teaching Thinking Skills: Theory and Practice (1987)

"In an experiment on the teaching of mathematical problem solving conducted by Alan Schoenfeld (1979) the students were divided into two groups. One group studied a series of worked-out solutions to problems that demonstrated certain problem-solving techniques; however, the materials did not identify the problem-solving techniques. Another group studied the same series of solutions with overlays that highlighted the tactics being used. Both groups practiced solving problems. Whereas the second group showed marked gains in problem-solving performance, the first showed none at all."

Langley, Simon, Bradshaw, and Jyotkow, Scientific Discovery (1987)

"The work reported in this book derives from the hypothesis that, if there is no single 'scientific method,' there are at least a number of scientific methods that are broadly applicable over many domains of science. This is not to deny that there are also special methods, some of them applicable to only very narrow realm, nor is it to claim that general methods are more important for carrying out scientific work successfully than are special ones. Our only claims are that relatively general methods do play (and have historically played) a significant role in scientific discovery, that such methods are numerous, that they can be identified, and that their effects can be studied."

J.A. Easley, Jr., Scientific Method as an Educational Objective, The Encyclopedia of Education (1971)

"Scientific method is the set of general principles which guides scientists (consciously or unconsciously) in the search for new knowledge and which serve scientists and laymen alike in the evaluation of claims to knowledge. Such principles are sometimes appealed to as criteria to distinguish scientific thought from non-scientific thought, but this sharp distinction no longer appears possible."

"Method" as Used in "The Scientific Method" Means a Guide

Throughout this booklet, it is stated that misunderstandings and misinterpretations have caused people to claim that "The Scientific Method" does not exist. For this reason, we put quotation marks around it.

Some oppose "The Scientific Method" because they claim that there can be no one method by which scientists break new ground. This is correct . . . there is no one "method." The correct interpretation of "method" (as used in "The Scientific Method") means that it is only a guide, consisting of a number of ingredients used in a very flexible manner. Under these ingredients, you apply thinking skills to use creative, logical, and technical methods to actually accomplish results.

SM-14 IS A GENERAL METHOD

The usual, *narrow* view taken of "The Scientific Method" is that it is a method used only by scientists following certain steps. Five years of research and review of hundreds of books indicate that it is actually a general method for problem origination, prevention, solution, and challenge of solution. This is the view taken by many great and famous men, a few of whom are quoted here.

T.H. Huxley (1825-1895)—biologist and British philosopher

The method of scientific investigation is nothing but the expression of the necessary mode of working of the human mind. It is simply the mode at which all phenomena are reasoned about, rendered precise and exact. Darwiniana, "We Are All Scientists" (1863), reprinted in A Treasury of Science (1948).

Karl Pearson (1857-1936)—British author and professor of mathematics

The scientific method of examining facts is not peculiar to one class of phenomena and to one class of workers; it is applicable to social as well as physical problems, and we must guard ourselves against supposing that the scientific frame of mind is a peculiarity of the professional scientist. The Grammar of Science (1892).

John Dewey (1859-1952)—one of America's greatest philosopher-educators

Scientific method includes, in short, *all the processes by which the observing and amassing of data are regulated with a view to facilitating the formation of explanatory conceptions and theories.* How We Think (1933, p. 171).

Albert Einstein (1879-1955)—physicist and Father of Theories of Relativity

The whole of science is nothing more than a refinement of everyday thinking. It is for this reason that the critical thinking of the physicist cannot possibly be restricted to the examination of the concepts of his own special field. Out of My Later Years (1950).

Noah Porter (1811-1892)—philosopher and president of Yale College (1871-1887)

It follows that we can nowhere find the dividing line which separates common from scientific knowledge. We cannot say, in the history of any branch of knowledge, "Here common knowledge ceases and science begins." At this point he who knows as a man, begins to know as a philosopher. The Human Intellect (1868).

Herbert A. Simon (1916-)—psychologist, Nobel Laureate, Father of Artificial Intelligence

In many of his books, Dr. Simon has called attention to the general or universal nature of problem solving. The quotation below is of special interest as it compares decision making to problem solving.

When Harold brought to these sessions his earlier research on problem solving, we began more and more to see decision-making processes as essentially the same as problem-solving processes. My own economic theorizing was leading me in a similar direction. Models of My Life (1991).

Irving M. Copi (1917-)—philosopher-educator, author of many books on logic

As the term "scientific" is generally used today, it refers to any reasoning which attempts to proceed from observable facts of experience to reasonable (that is, relevant and testable) explanations for those facts. The scientific method is not confined to professional scientists: anyone can be said to be proceeding scientifically who follows the general pattern of reasoning from evidence to conclusions that can be tested by experience. The skilled detective is a scientist in this sense, as are most of us—in our more rational moments, at least. Introduction to Logic (1982).

Author's Note: This booklet has been prepared as a public service, in the scientific spirit of challenge of a prevailing concept in national education reform programs that questions the existence of "The Scientific Method." After five years of research, my opinion is that this prevailing concept is erroneous, unfruitful, and extremely harmful to our country. Many short quotations have been used under the "doctrine of fair use" for purposes of criticism, comment, education, and research.

So many references were consulted that it was not practical to list them all. I acknowledge my indebtedness by stating on the front cover, "Compiled and written by."

CHAPTER II
THE ADVANTAGES OF TEACHING AND LEARNING SM-14

WANT MORE JOBS? TEACH AND USE SM-14

There is much talk and great concern about the need for more and better jobs. Stimulation of the economy will produce some new jobs, but the illustrations below show how we can prevent the loss of jobs as well as allow for the continuous production of new jobs. For long-term results, we must teach SM-14 to all students. For more immediate results, we must teach SM-14 to adults already in the work force.

Research and Technology

Dr. Percey Julian

American research and technology contribute dramatically to the number of jobs available. Improve funding, efficiency, creativity, and training, and even more and better jobs will be produced. Research and technology development is already making *knowledge* our largest industry and job producer. Adults need to learn SM-14 as well as students.

Inventors

Thomas A. Edison

More and better inventions are needed. Rossman's 1930 survey in *Industrial Creativity* shows that methods used by inventors in new product development, design, and engineering closely match the SM-14 formula. Thus, widespread teaching of SM-14 will result in more inventions that can create many new and better jobs.

Entrepreneurs and Innovators

Thomas J. Watson

Responsible for the creation of a substantial portion of new jobs of all types, these are idea people; risk takers; problem originators, preventers, solvers, and challengers of solutions. More teaching of SM-14 to students and adults = more entrepreneurs and innovators = more and better jobs!

A Creative, Problem-Solving Work Force

Workers who can originate, prevent, and solve problems will keep the USA competitive and expand its markets, which will produce more and better jobs. Widespread teaching of SM-14 is the answer!

Scientific Management

Scientific Management is the application of SM-14 to managing. Managers should be taught and encouraged to use SM-14 to improve their skills. This prevents loss of jobs due to falling behind global competition and it increases product development and sales. This all adds up to more and better jobs.

All Fields of Endeavor

SM-14 is a general method for *all fields of endeavor* and for all people. Widespread teaching will increase creativity, knowledge, and competitiveness. This, in turn, will produce more and better jobs!

Teaching SM-14 Enables Creativity to Flourish

Many theories expressed today state that *tracking* (grouping by level of ability) of students should be eliminated from school systems. A major danger of this discontinuance is that the development of our most intelligent, gifted, and creative students (the greatest job producers of the future) would be tragically neglected.

SM-14 (which allows each student to choose their own problems to solve) offers *all* students a chance to develop their own special talents and ambitions. Mothers often spot special abilities in their children. With SM-14 as the basis for student portfolios, teachers would also be able to spot special intelligences and abilities.

Arnold Skromme, in his interesting book, *The 7-Ability Plan* (1989), states, "It took some strong criticism from mothers to make me realize that children had other abilities that were not identified by their grades (or IQ). This led to the most important part of this book . . . the 7-ABILITY PLAN for educating our children." This plan includes creativity as one of its abilities.

"In economics the significance of creativity is total employment—more things for more people."
The Nature of Creative Thinking, J. Rand (1952), a monograph sponsored by the Industrial Research Institute.

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WHAT IS SCIENCE?

SM-14 can considerably aid in teaching science, thus helping students attain scientific and technological literacy. There are thousands of definitions of science. Part of our basic body of knowledge is that the best hypothesis is the simplest hypothesis . . . so, what *is* science? Science has two basic parts:

1 **The basic body of knowledge about nature.**

2 **The basic method, formula, or guide by which we refine, extend, and apply this basic body of knowledge.**
This is usually accomplished through problem origination/prevention/solution and challenge of the solution. This basic method, formula, or guide has been called many names over the centuries. The more popular ones are:

The Scientific Method	Scientific method	Experimental Method	For other names,
A scientific method	Method of Inquiry	Method of Discovery	see Page 34

SCIENTIFIC (AND TECHNOLOGICAL) LITERACY

There have been numerous books, articles, and school reform reports which lament our lack of scientific literacy. My research indicates that a major reason for this is that even though science consists of two basic parts (as explained above), the course our science teaching has taken is:

PART #1—***We have mainly taught only science subject matter in science classes.***
Our body of scientific knowledge is growing so fast that it is difficult to keep up with. It really almost requires a yearly review of what subject matter to teach. We must also remember that only a small fraction of what subject matter is taught will be retained.
PART #2—***We have failed to adequately teach "The Scientific Method" or to understand what the process of science really comprises.***

To attain Scientific and Technological Literacy, we must:
TEACH THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

- It must be taught across the curricula, as it is a general method.
- Science teachers should help by showing its application to nature, including possible social implications. Also, the special techniques, methods, and care that scientists often use need to be taught.
- In utilizing Hands-On, Inquiry, and Discovery Methods of teaching science, we must include and show the relationship of THE GENERAL PATTERN OF THE SCIENTIFIC METHOD to these. It is the way to achieve transfer of learning and training through the second basic part of science.

The Technology Panel of AAAS' Project 2061, in their 1989—Phase I Report, states:

Technology education should emphasize problem solving. The posing and solving of problems, increasingly complex as students move from kindergarten through the twelfth grade, will enable students to develop techniques that are vital to living in a technical world of diverse cultures and technical status. The problems and their solutions may be technical, experimental, mathematical, technical-social, or value-laden. Designing alternatives to circumvent problems and learning to deal with options are also important techniques . . . Observation, measurement, and analysis are universal tools of technology . . . Intelligent observation is crucial to invention . . .

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THE DIGITAL INFORMATION SUPERHIGHWAY (DISH) AND OTHER INFORMATION TECHNOLOGIES NEED THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

Information technologies have been developing at an ever faster rate. We now have the Digital Information SuperHighway (DISH) being built, at an estimated cost of 250 billion dollars. Information, however, does not always represent knowledge itself but, rather, the potential for it. This is why *The General Pattern of The Scientific Method (SM-14)* is of vital importance in the use of all of the constantly changing and increasing information and knowledge that becomes available.

CHANGES WILL BE EVERYWHERE

Information technologies affect us all, changing much of our lifestyle. This change will be especially dramatic in the education field. The answer is SM-14: the method of change. Teach SM-14, and you can expect impressive results (a possible 90% improvement) in how changes are handled.

EVALUATION & ANALYSIS

To turn information into knowledge, people need to be properly motivated into using SM-14's Ingredient #1—Curious Observation. It is the most effective way to sift through this flood of:

- Current events
- Expertise
- Raw data and statistics
- Peer-reviewed journals
- Opinions—good and questionable
- Trivia and trash
- All variations of these

To evaluate and analyze all of this, given the inevitable time limitations, people are often going to have to use their intuition. Study and experience in using SM-14 is one of the surest ways to build a strong intuitive base. When important enough, SM-7 or SM-14 will be applied for a more reliable or verified evaluation and analysis. Again, a possible 90% improvement can be realized with the use of SM-14.

REFINE & EXTEND KNOWLEDGE

This curious observation and evaluation will provide people with problems with which to refine and extend personal and societal knowledge. "Muddling around" is not an efficient process. SM-14's ingredients combined with thinking skills will help to utilize creative, logical, and technical methods and processes for results that are plausible, probable, and practical. This all adds up to a substantial increase in the amount of knowledge being refined and extended.

APPLICATION OF KNOWLEDGE

SM-14 is also the method to use in applying knowledge. For some complex applications, new technologies must be developed. This involves problem origination, prevention, solution, and the challenge of solution. The use of SM-14 and DISH together is essential for realizing the greatest possible increase in the number of applications.

WHO PAYS? AND HOW MUCH ?

For the information highway to reach its objectives, it must be an economic success. It is going to be very expensive and must, therefore, generate a huge amount of revenue. The educational community is asking for special rates.

- This is justified, as they can turn digital information into knowledge and technologies that will benefit the other users of the highway (DISH).
- Schools teaching SM-14 and DISH will be sending job applicants into the work force better prepared and already familiar with using DISH.

IT'S GOING TO TAKE CREATIVE PEOPLE

The economic success of DISH is going to require a constant supply of innovative and creative people in all fields. Teaching SM-14 is training in creativity. TODAY, 90% of our population has not been adequately taught creativity; innovation; thinking skills; problem origination, prevention, solution, and challenge of solution. Now is the time to change this. Many school reforms are being planned, and the teachings of SM-14 and DISH should be included. FORECAST: Teach SM-14 across the curricula, teach the use of the digital information superhighway (DISH) in all subject classes, and you will increase America's jobs and prosperity to a degree that will boggle the mind! There are no limits as to what a creative and innovative work force can do. For further insight about the great harm that has been done by not teaching SM-14 in the past, please read Pages 21 and 43 .

SM-14 IS THE METHOD OF INVENTION AND CREATIVITY

While researching, I found only one large survey pertaining to the method of inquiry, discovery, invention, and creativity (which was in Joseph Rossman's excellent book, *Industrial Creativity* [1930]). While the survey is an old one, the basics have remained the same. This survey questioned 710 inventors (inventing is, after all, one of the many forms of use of SM-14), asking them to state what methods they followed while inventing. Rossman's careful analysis reduced their inventing procedures to the list in the left-hand column below. The right-hand column contains the SM-14 ingredients. Note the similarities!

ROSSMAN'S SURVEY— METHOD OF INVENTION (1930)	THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)
1. Observation of need or difficulty	1. Curious Observation
2. Analysis of the need	2. Is There A Problem? 3. Goals and Planning
3. Survey of all available information	4. Search, Explore, and Gather the Evidence
4. Formulation of all objective solutions	5. Generate Creative and Logical Alternative Solutions
5. Critical analysis of these solutions for their advantages and disadvantages	6. Evaluate the Evidence
6. Birth of the new idea—the invention	7. Make the Educated Guess (Hypothesis)
7. Experimentation to test the most promising solution; the selection and perfection of the final embodiment by some or all of the previous steps	8. Challenge the Hypothesis 9. Reach a Conclusion 10. Suspend Judgment
Inventors left "Take Action" as understood	11. Take Action
SM-14 includes these as important supporting ingredients, especially valuable for teaching	12. Motivation and Sensitivity 13. Personal Attributes 14. Thinking Skills, Methods, and Processes

CREATIVE PROBLEM-SOLVING PROCESS SPONSORED BY CREATIVE EDUCATION FOUNDATION

Current Osborn-Parnes Process
Objective Finding
Fact Finding
Problem Finding
Idea Finding
Solution Finding
Acceptance Finding

The formula to the left evolved from the one that Osborn originated and included in the first edition of *Applied Imagination* in 1953. A revised edition of this excellent book is still in print (available from CEF). All problem-solving methods are just variations of the centuries-old "The Scientific Method." This variation is better than most, as it stresses both finding problems and creative idea finding. As a result of the Creative Education Foundation's efforts, it has been used in thousands of seminars and classes and has been included in hundreds of books. If you will compare this formula to SM-14 (above right column), you will note that SM-14 is more complete and the terminology is more explanatory. As part of standardization, I recommend that everyone interested in creative problem solving use the SM-14 terminology.

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SM-14 PROMOTES INNOVATION AND CREATIVITY

In order to produce more jobs and meet global competition, America must do more to teach and promote innovation and creativity. Most school restructure reports call for improving students' creativity. SM-14 promotes learning creativity throughout the process, and especially in:

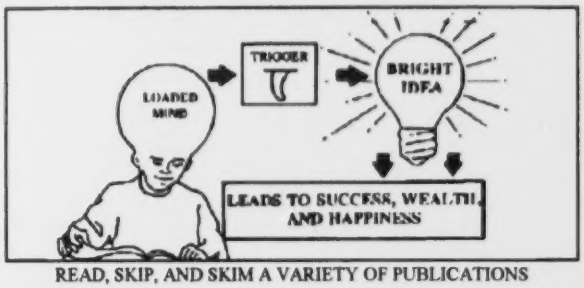
Ingredient #1

Curious Observation

Ingredient #4

Search, Explore & Gather the Evidence

Ingredient #5: Generate Creative & Logical Alternative Solutions



READ, SKIP, AND SKIM A VARIETY OF PUBLICATIONS

Creativity—difficult to teach successfully, but we must try!
Creativity *can* be taught and encouraged, especially if started early in life. Motivation and hard work are involved in learning to be creative. Success may be limited, despite persistent teaching efforts, but even limited success will add billions of dollars to our economy. New teaching materials are desperately needed, as well as a summarization of all existing ideas and ways to teach creativity.

Innovation: The seeking out, adaptation, and implementation of ideas. They can be new or old, domestic or foreign. *The innovator need not be the creator of the idea,* just the implementer and adapter. Hopefully, though, the innovator will add some creativity in the implementation and adaptation efforts.

THE OBJECTIVE SHOULD BE TO TEACH INNOVATION AS WELL AS CREATIVITY!

The advantages of and need for teaching innovation separately—

- *Innovation is a great deal easier to teach and learn.* The average person is always doing a little innovating and being motivated by circumstances to change. Innovation doesn't require a very creative person.
- *Creative ideas are of little value without numerous innovators and entrepreneurs to apply them.*
- *Innovation is the best training for creativity* (Japan is a good example of this).
- *Students would learn to be more competitive.* This would aid the speed and quality of our innovation cycle on a national level. It would prepare students for all the changes which they are going to face.

CREATIVITY IQ

We must help those who may not be tops academically but have innovative and/or creative skills. This story illustrates why it is not always those with a high IQ that succeed in life.

Moral of the story: Think reflectively—imagine—be creative—search for The Big Picture.

The Beagles:

- Highly trained
- Excellent followers
- Keen sense of smell and purpose
- Dedicated, hard-working, and eager to succeed in what they were trained to do

Spot, the mongrel dog:

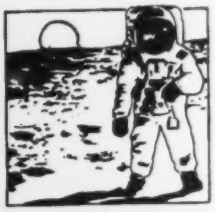
- Only partially trained
- Self-educated
- Average sense of smell
- Field smart
- Through trial and error and research, Spot soon learned that a frightened rabbit has a tendency to circle when chased

So . . . Spot, The Mongrel Dog, quietly stands up or leaps above the surrounding obstacles to see The Big Picture. He spots the proper path to reach his objective and succeeds before those who, although highly trained, don't see The Big Picture—they only follow their noses!

ADAPTED FROM A STORY IN ARNOLD SKROMME'S *THE SEVEN ABILITY PLAN (1989).*

THIS IS ONLY AN ANECDOTE AND NOT INTENDED TO ENCOURAGE RABBIT HUNTING WITH DOGS

TEACHING SM-14 VS. SUBJECT-CENTERED CURRICULA



Because of thorough searching, exploration, and information gathering, the teams of NASA scientists, engineers, technicians, and astronauts were able to solve the problem of landing man on the moon

Teaching THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) is problem-origination and -solving education, and the opposite of a subject-centered curricula or reception learning. Professor Hollaway in his book, *Problem Solving—Towards a More Humanizing Curricula* (1975), thoroughly expresses the deficiencies of using only a subject-centered curricula. On Page 3 of his book, he states:

The best that can be said of the subject centered curriculum is that it is a rapid succession of recorded events that may be run over in the mind of an individual and which may have no impact upon his behavior or upon the improvement of the society. It almost totally ignores and neglects the past experiences, aspirations, interests, needs, and uniqueness of the individual learner.

Directed toward the mastery of subject matter in a uniform manner, it demands the same learning of all individuals—without regard for their need for such learning or how they can apply it in solving individual problems. Proponents of the subject centered curriculum look upon an individual's ability to master contents within a text or manual as evidence that learning has taken place. Such simplistic reasoning is contrary to the newer learning concepts that:

1. *Learning is resolving a tension, overcoming an obstacle standing in the way of the achievement of a goal the learner needs or wants to achieve;*
2. *Learning is an interacting process involving the total organism and the total life situation;*
3. *Learning is discovery of personal meaning resulting in changed behavior.*

Professor Hollaway, in the preface of his book, explains what happened to our educational system:

Many leading educators endeavored to launch reforms after World War II aimed at making education more responsive to the needs of students and a democratic society. A large number of outstanding experimental programs were moving effectively forward but were challenged by critics of life-centered, problem-centered education like Bestor, Conant, Hutchins and Rickover. These critics and many others became more vocal following the launching of Sputnik in 1957. Such events created doubt in the minds of many Americans concerning the quality of American education and its leadership. Pressure demanded a return to the uniform college preparatory, subject-centered curriculum.

My research shows that while we have many curriculum reform programs today, most do not include real problem solving, "The Scientific Method," or SM-14.

On Page 4 of his book, Hollaway continues:

. . . the subject centered curriculum fails to develop effective methods, reflective thinking or try out innovative ideas. Its ready-made answers rule out alternatives. It need not project hypotheses or collect and organize information to test them. It need not draw generalizations and conclusions or evaluate them. Worst of all, it need not apply solutions to everyday life.

Additional comments on subject-centered curricula:

Henry Cole, in *Process Education* (1972), states:

It appears that the best way to insure a population of knowledgeable individuals is not by direct instruction in knowledge but by education for skills related to curiosity, problem-seeking and - solving, creative production and expression, and self-initiated learning. Studies of creative individuals who are also capable problem-solvers have shown they have acquired huge stores of knowledge. Such individuals are avid seekers of knowledge, always adding to their store.

MIT Professor Papert, in *Teachers Magazine* (Jan. '94), argues that:

The institution of School, with its daily lesson plans, fixed curriculum, standardized tests, and other such paraphernalia, tends constantly to reduce learning to a series of technical acts and the teacher to the role of technician."

AMERICA MUST ABANDON THE CONCEPT OF THE SUBJECT-CENTERED CURRICULA

This type of curricula is as antiquated as the Model T Ford. We will fail as a nation if we stick to it. These points clearly indicate this:

- Tremendous explosion of knowledge and the information technologies. Subject-matter teaching cannot keep up.
- Employers are demanding better thinkers, problem solvers, more technical skills and better personal skills.
- Global competition is more aggressive than ever.

THE SOLUTION

Our curricula must be revised to include teaching SM-14 and use of information technologies in all grades and across the curricula, to be correlated with teaching subject matter.

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SM-14 CAN INCREASE EFFECTIVENESS OF THE CASE METHOD OF TEACHING

The case method of teaching is frequently used in schools, colleges, universities, businesses, hospitals, industries, and in subject areas such as:

Management	Medicine	Business	The Arts
Science	Engineering	Agriculture	Social Studies

The method of case studies in law is a special class, and comments here may not apply. For reasons explained in Chapter VI, there has not been a good formula (such as SM-14) available to those teaching the case history method. The use of SM-14 would substantially improve the effectiveness of the case method of teaching.

In considering the case method, we should remember that most of our thinking is used for problem solving (see Page 7). Thus, almost all of our activities involve problems of knowledge, things, and people. For example, a business is a series of problems and sub-problems (*remember that decisions are basically problems*). How to plan, organize, control, measure, decide, and motivate are all problems. These problems are of the types (and variations of) presented in the chart below.

This review of SM-14 is to explain why you should learn to use this method to understand, analyze, and abstract concepts of cases being discussed in classes.

(1) Ill-structured and/or Complex Problems	(2) Intermediate-type Problems	(3) Quickly "Solved" Problems (Intuitive or Spontaneous)
Use SM-14 for this type of problem. It is the basic method by which we refine, extend, and apply knowledge; which is usually through problem origination, prevention, solution, and challenge of solution. By utilizing the 14 guiding ingredients of SM-14 and employing thinking skills, you use creative, logical, and technical methods and processes to actually achieve results.	Use SM-7 (see Page 6) when time, importance, and/or complexity of the problem doesn't require the full use of SM-14. This formula will help you build an awareness of considering alternatives. ***** In both #1 and #2, you are using a comprehensive guide, rather than just "muddling around."	If there is no time or a decision is made not to use SM-14 or SM-7, use the quick approach. ***You should build an intuitive base of:*** knowledge • experiences • methods processes • creative ability • formulas innovativeness • guides • concepts basic principles • patterns • relationships personal attributes • reasoning • judgment abstraction • visualizing . . . and, in general, thinking skills of all types. ***** You will sometimes get a flash of inspiration which will provide a tentative solution.

Knowledge and Use of the Supporting Ingredients of SM-14 are Needed by Students in Case Method Study

Ingredient #12
Motivation & Sensitivity
SM-14 trains you in knowing how and what motivates people and helps develop a human awareness or sensitivity to people and to things (such as clues, leads, differences, patterns, etc.).

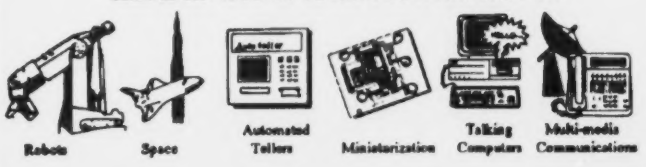
Ingredient #13
Personal Attributes
These play a big role in case studies of what people did or should have done. Honesty? Courage? Progressiveness? Curiosity? Other attributes are discussed in the SM-14 Student Booklet, Ingredient #13.

Ingredient #14
Thinking Skills, Methods & Processes
Thinking Skills
Simple, low, high, critical—all are essential in case studies.
Methods and Processes
Creative, logical, and technical methods learned in the use of SM-14 can be of help in case studies.

Learn with understanding—transfer of learning in one task to varied tasks

In case method, students are usually provided with much information and details that will probably be forgotten. However, *methods* learned and used will always be remembered throughout life and applied to other problem situations, regardless of domain or case involved. Thus, methods should especially be taught and tied into case studies.

SM-14 HELPS MEET NEEDS OF EMPLOYERS



High-paying unskilled jobs are disappearing—skilled, innovative, creative, problem-solving, adaptable workers are needed!

Employers Want "Problem Solvers"

In education restructure reports, employers are asking for schools to send them students who can solve problems. Numerous school reform reports call for the teaching of problem solving.

What do they mean by "problem solver"? Amazingly enough, in this age of knowledge and fast technological growth, we have no standard definition or formula for problem solving—yet almost everyone wants problem solving taught and acknowledges its importance! In most cases, however, people only have a general idea of what they mean. Frequently, things are called problem solving when, in reality, they should be called:

- Exercise Problems
- Textbook Problems
- Puzzle Problems

Research shows, however, that what is really being called for are people who are able to think better, have desirable personal attributes, and are capable of:

- Problem Origination
- Problem Prevention
- Problem Solution
- Challenge of Solution

To supply employers with "problem solvers," the solution is to teach SM-14 across the curricula.

Outcome-Based Education

Or "meeting the needs of employers" or "more humanizing curricula" or "practical intelligence" or "workplace know-how" . . . whatever you call it, the movement to prepare students for life and their careers requires teaching of SM-14. The current squabbles about a tiny part of curricula reforms concerned with "values" requires intelligent compromise or explanations, but not the death of the movements.

THE STUDENT PORTFOLIO—ALTERNATE ASSESSMENT MOVEMENT NEEDS SM-14

Joan McRobbin, in a Knowledge Brief of the Far West Laboratory for Education Research and Development, reports in *R&D Preview*, ". . . portfolio designers must identify their criteria for scoring. The criteria must be as complete as the problem solving and higher-order thinking skills that the portfolios are designed to measure. And the criteria must be clear to students and scorers."

The student portfolio movement (to improve on testing) has not yet found a base. It is experimenting with an assortment of procedures and criteria, including some problem solving using miscellaneous formulas.

The Key—Adopt, as a national standard base for all alternative testing, the use of THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) or similar. Students would be required to use it as the base in preparation of their portfolios. An alternate idea for portfolios is for a student's entire self-development program to be the base. (See Page 45 of the Student Booklet for a self-development program.)

ESSAYS VS. REPORTS PREPARED WITH SM-14 AS THE GUIDE

Essays are currently being required on many college entrance applications as well as for portfolios. A report prepared by a student on how he originated and solved a problem, utilizing the thinking skills and creative, logical, and technical methods used under the ingredients of SM-14, is a far better example of ability than an ordinary essay.

YOUR PERSONAL LIFE NEEDS SM-14

Huxley, Pearson, Dewey, Crooks, and many others all advised us to use "The Scientific Method" in our personal lives. Their advice was very logical, since THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) is a general method for problem originating, preventing, solving, and challenge of solution.

Here is how SM-14 can help people in their personal lives . . .

HEALTH
Acquiring SM-14 skills raises your self-esteem and prevents needless worry. *Conquer Chronic Worry*, an article in the November 1993 issue of *Prevention* magazine, quotes several psychologists who advise their patients to learn to be problem solvers. Health problems may be prevented or improved if you are a good problem originator and solver.

MARRIAGE

Too many marriages are unhappy or break up because people are not better problem originators, preventers, solvers, and challengers of solutions.

CHILD REARING
In today's environment, raising children involves much problem preventing and solving. Obviously, if you're a good problem solver, you are going to be a better parent.

HOBBIES—THE ARTS

Hobbies all involve thinking skills and problem solving. Learn SM-14 and enjoy your hobby more. In The Arts, creativity has been necessary and lauded as what makes the difference between mediocrity and success and fame. SM-14 brings out your creativity.

PERSONAL ATTRIBUTES
Progressive educators are pointing out that we must pay more attention to developing better values and attitudes (part of a broader classification of personal attributes). SM-14 stresses the importance of personal attributes.

EDUCATION & CAREERS

Knowledge is doubling fast, and our memories can only retain a small percentage of what we learn. Thus, we must spend more time learning the basic golden formula, SM-14, and the thinking skills, creative, logical, and technical methods used under SM-14's ingredients. These will be retained in memory and used often.

FINANCES
Using SM-14 in your personal life will enable you to increase and better manage your earnings.

OTHER AREAS
All other areas of your personal life will be improved if you have developed the thinking skills and know-how required for proficient decision making and problem origination, prevention, solution, and challenge of solution. ***Remember, the biggest challenge in your life today is change, and SM-14 is the Method of Change!***

ADD TO WORLD AND PERSONAL KNOWLEDGE
You must learn SM-14 in hopes that you will add to the world's body of knowledge. Equally important, it will also aid in refining, extending, and applying your own body of knowledge. Life is one problem after another (or, better said, one opportunity after another)! The need to know this method and to learn the thinking skills and methods used under its ingredients is basic to your progress and contribution.

CITIZENSHIP

Personal voting and understanding of current issues at all levels of government is greatly enhanced by a thorough knowledge of SM-14. Training in innovation and creativity (a large part of SM-14) helps us to increase the GNP and improve the common good in all areas. Training in Personal Attributes (another important part of SM-14) will make better citizens of us all, ready to accept our responsibilities.

SELF-ESTEEM & SELF-IMAGE
Educators today are stressing the importance of self-esteem. True self-esteem comes from our knowledge and self-confidence that we can think through and solve problems. That is the self-image for which to strive.

DISADVANTAGED STUDENTS ESPECIALLY AIDED BY STANDARDIZED SM-14

Minorities and economically disadvantaged students often have special learning problems. Frequent moves (according to a recent study, one in six of the nation's third graders have attended at least three different schools since the first grade), inferior schools, lack of two-parent affection or supervision, languages other than English spoken in the home, poor nutrition, etc. can slow the learning process and make a good education seem impossible. By standardizing on SM-14 for all grades (and across the curricula), these students would stand a better chance of "beating the odds."

Problem: Frequent Moves	**Problem: Unable to finish high school or go on to college**	**Problem: English is not the language spoken at home**
Answer: If thinking skills and problem solving (SM-14) were standardized on and taught in all schools, mobile students would have a better chance of learning, retaining and utilizing what they were taught.	**Answer**: A basic training in SM-14 would give these students the thinking skills and problem-solving abilities which employers are demanding in this era of global competition.	**Answer:** Standardization would make it practical and econom-ical to print SM-14 lessons in other languages, to aid students and their parents in learning both SM-14 and English.

Greater Student Motivation Means Better Class Discipline and More Learning

Surveys show that many disadvantaged students are bored in the usual subject-centered classes. When taught thinking skills and problem solving, especially when allowed to choose their own problems for solving, they quickly realize how important this training is to their present and future lives. They are less likely to apply or heed peer pressure which says, "Don't study!" They develop more positive attitudes and are better motivated to learn in class. All of this improves their self-esteem, based on confidence in their ability to solve problems.

Standardization would make it practical to incorporate SM-14 into the following: • Head Start Programs • Home Learning • TV Educational Programs • Adult Education Programs • Job-training Programs • Computerized Games • Early Childhood Books • Discussion & Testing	Discussion-type and Team-teaching Methods Students like and are asking for more discussion-type teaching. Minority students often need more help in developing verbal skills. The teaching of SM-14 requires discussion and debate, and draws them into better expressing themselves.	More Personal Problems Disadvantaged students face many more difficult problems than their fellow students. The more problem-origination, -prevention, and -solution skills they are taught (SM-14), the better prepared they will be to deal with their own problems, whether at school or at home.

Besides offering disadvantaged students the opportunity to carry their acquired skills with them, the standardization of SM-14 would provide effective means for partnering to better help these students. Students would gain better-paying jobs and employers would gain better employees—not just workers, but thinkers, also. Learning SM-14 will also better motivate students to pursue careers in science and technology.

OTHER AREAS THAT NEED SM-14

Legal Affairs and Law Practice

Davis, in his quotation on Page 22, calls attention to the scientific method of approach being the same as the "legal method of approach."

Frank, in *Law and the Modern Mind* (1970), states:

> While lawyers would do well, to be sure, to learn scientific logic from the expositors of scientific method, it is far more important that they catch *the spirit of the creative scientist*, which yearns not for safety but risk, not for certainty but adventure, which thrives on experimentation, invention and novelty and not on nostalgia for the absolute, which devotes itself to new ways of manipulating protean particulars and not to the quest of undeviating universals.
>
> The experimental approach would be peculiarly serviceable in law. For the practice of law is a series of experiments, of adventures in the adjusting of human relations and the compromising of human conflicts. The paradox is that where this approach is most needed it is all too frequently repudiated. In one sense it is constantly in use, for the daily job of the lawyers would fail without it. But while we lawyers use it, we discount it.

Debating

Preparing for a debate on *any* complex subject requires the application of SM-14, whether it be a legislative, business decision, or any other type of problem.

Investigations and Detective Work

An investigator should use SM-14 as a guide. It is the basic method of inquiry and discovery.

Copi, in *Introduction to Logic* (1982), describes how Sherlock Holmes uses the general pattern of scientific research in solving cases.

Medical Diagnostics

If you look at SM-14, it is very apparent that it is the guide that a doctor, nurse, or researcher should use in diagnosing a patient.

Artisans and Vocational Training

History shows that the artisans of old were unknowingly some of the early users of "The Scientific Method." In this era of technological advances, workers (more than ever) need to use SM-14. However, with today's pace, it must be taught rather than just used unconsciously after years of experience.

Research in Any Field

The art of investigation in all fields requires the use of THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14). "Operation Research" formulas are just another variation of SM-14.

Investing Funds

Investing funds is just another activity that requires problem origination; prevention of mistakes; solutions; and, certainly, challenge of any decisions; followed by an open mind.

All Other Fields

Our personal and professional lives are all problem-oriented. Successful individuals will be those who learn and apply SM-14.

SM-14 Can Make a Substantial Contribution to Environmental Protection and Improvement

The environmental movement has been less effective because:

- There are a number of those who, for the sake of making a profit, deny that they are doing any harm, based on biased opinions and/or flawed research.
- There are a number of those who claim harm is being done to the environment, based on unlogical reasoning, emotion, and flawed or no research.
- Those in positions of power and decision making are subjected to the pressure or influence of these people or organizations, without being provided with a base to arrive at decisions or solutions that includes a high degree of plausibility, probability and practicability.

Problems and disputes should be researched in an honest, unbiased, unemotional way to the usual standards of the scientific community and using SM-14 as a guide. Under its ingredients (utilizing thinking skills), researchers will use creative, logical and technical methods in order to arrive at a concluding educated guess or hypothesis with a high degree of plausibility and probability. After that, comes practicability and intelligent compromise to arrive at a final solution or decision.

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HARMFUL RESULTS OF NOT TEACHING SM-14

Dr. James Feibleman, while Chairman and Professor of Philosophy at Tulane University, wrote the book, *Scientific Method.* Written in 1972 and aimed at the physical sciences, what he wrote remains true to this day, since a complete formula such as SM-14 is still not being taught.

At the present time science is taught largely on the apprentice method, and the scientist is not particularly aware that he is following any established procedure; rather is he always occupied with some specific problem involved in that procedure, guided chiefly by past experience, by accepted tradition, training, memory, and imitation. In the laboratories of schools and colleges, in addition to the memorizing of sets of names for entities and processes, and the standard formulations of established laws, the scientific procedures are communicated by means of the endless repetition of certain of the classical experiments. Even though there is no substitute for concrete experience, taken alone it is crude at best and needs to be supplemented with a manual setting forth the outlines of the method as it is currently employed. This book, it is hoped, will fulfill such a need.

It is easy to find other examples of the harm done to students by misunderstandings of and the lack of standardization on THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

(1) Glen S. Aikenhead wrote "Authentic Science — What Do Students Believe?" This appeared in the recent National Association for Research in Science Teaching publication, "Research Matters to the Science Teacher." The author described the completion of a stratified sample of 10,800 graduating high school students across Canada. The results of this sampling showed:

The "scientific method" was perceived differently by each student. Almost no one referred to the five or seven step method portrayed in textbooks. Many students believed that the scientific method entailed meticulously and rigidly following prescribed laboratory procedures. Is this perhaps a result of doing high school labs in a similar manner?

(2) Wayne A. Wickelgren, in *How To Solve Problems* (1974), states:

In the mathematics and science courses I took in college, I was enormously irritated by the hundreds of hours that I wasted staring at problems without any good idea about what approach to try next in attempting to solve them. I thought at the time that there was no educational value in those "blank" minutes, and I see no value in them today.

(3) The American Society for Engineering Education published *The Teaching of Elementary Problem Solving in Engineering and Related Fields* (1980), edited by James L. Lubkin. In an essay in this book, Donald R. Wood, Cameron M. Crow, et al, stated:

Students do not have an organized method of defining or thinking about problem solving. They just "do their thing." To many this meant starting to solve a problem with whatever came into their head first. To others this meant that they tried to locate a worked example problem. Still others found they just did not have confidence to do anything; getting started on solving any problem was just a traumatic experience. When they got "stuck" on solving a problem, few could describe where they were, what was causing the difficulty and what obstacle they were trying to overcome. In trying to develop plans for solving problems, too many students try to solve problems by "playing around with the given symbols and data" until they find an equation that "uses up all the given information." Such a dependence means that the students cannot function when they are given problems where too much or insufficient data is given.

The following was excerpted from the Proceedings of the International Interdisciplinary Conference on Thinking, held at the University of South Pacific (1982), and published in *Thinking & The Expanding Frontier* (1983).

The teaching of thinking skills, historically, occurs very early in all societies by a host of other devices as well: puzzles, games, detective stories, long narratives requiring complex memory strategies and heuristics, etc. Yet, despite the cultural universality of the teaching of thinking skills, there is general agreement that all societies, without exception, today do a poor job of teaching problem-solving skills that are necessary to live in the modern world.

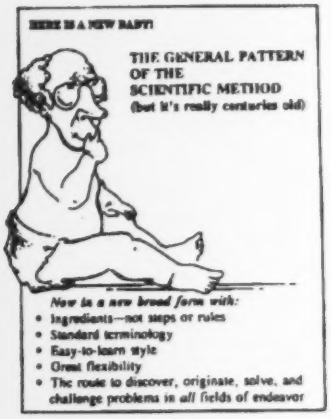
Diane F. Halpern, in *Thought and Knowledge* (1989), states:

Psychologists have found that only 25% of first-year college students possess the skills needed for logical abstract thought . . .

The economic harm resulting from not teaching SM-14 is described on Page 43!

CHAPTER III
MANAGEMENT SCIENCE & SCIENTIFIC MANAGEMENT

CLARIFYING MANAGEMENT SCIENCE AND SCIENTIFIC MANAGEMENT


HERE IS A NEW BABY!
THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (but it's really centuries old)
Now in a new broad form with:
• Ingredients—not steps or rules
• Standard terminology
• Easy-to-learn style
• Great flexibility
• The route to discover, originate, solve, and challenge problems in all fields of endeavor

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) is just an improved guide of the centuries-old "The Scientific Method," which is the basic method by which we refine, extend, and apply knowledge through problem origination, prevention, solution, and challenge of solution. It is not surprising that "The Scientific Method" was applied to management over the years, but the components of Management Science and Scientific Management have never been clearly defined. In fact, there have been many misconceptions.

Taylorism is not scientific management!

Frederick W. Taylor pioneered and introduced many management concepts. He is credited with being "The Father of Scientific Management" for his work started in the late 1800's. Many believe that Scientific Management consists of the concepts he introduced. Study has proven, though, that he merely applied his version of "The Scientific Method" for originating problems and for solutions, thus arriving at his conclusions or hypotheses. Scientific Management should not be restricted to any one person's concept or approach to it, or to any one phase of management.

The Nature of Management Science and Scientific Management

The best explanation that I found for classifying management as a science is that of Ralph C. Davis, Professor of Business Organizations at Ohio State University (1951), in his book, *The Fundamentals of Top Management*, where he states:

There is still considerable misunderstanding among some people concerning the nature of scientific management and what it purports to do. They feel that it is some formalistic, highly complicated system for running business organizations, based on theories that may not be quite practicable. It is supposed, in some vague way, that it may have something to do with engineering since the term "Scientific" is used. These are misconceptions, for the most part. A science may be any classified body of fundamental facts, principles, and techniques that explains certain basic phenomena, leads to the discovery of general truths and the operation of general laws. It may be "exact," as in the case of the physical sciences, or "inexact" as in the case of the social sciences. A scientific method, in its simplest terms, may be any method that applies a logic of effective thinking, based on an applicable science, to the solution of a particular set of problems. The "legal method of approach," as taught in our law schools, is merely a scientific method of approach to the solution of legal problems. The literature of business is sufficiently well developed and extensive to permit business to be regarded as a developing field of science. It is, however, an inexact, applied science. It has its roots in the social sciences. It may, like any other applied field, draw on any basic field of knowledge, including the so-called exact sciences. Scientific management merely attempts to apply the logic of effective thinking to the solution of business problems. It uses the applied business knowledge and principles that have been accumulated, classified, codified, and accepted to date, with due allowance for their limitations. It may or may not be complicated, depending on the degree of complexity of the particular managerial problem.

Imperfect, but Still a "Phenomenally Successful Process"

The method of applying THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) to management is imperfect but is far superior to such ways and processes as:

Hunch or gut instinct	Seat of pants	Doing your "own thing"
Haphazard guess	Uneducated guess	Applying existing knowledge
Common sense	Rule of thumb	Outdated intuition
Superficial analysis	Trial and error	Pig in the poke
Management by exception	Chaos	"We always do it that way"
Walk-around management	Fad of the day	Quick fix

While the application of SM-14 is far superior to the above, there are times when some of these serve a useful purpose (trial and error is always a basic way to progress). Proper use of SM-14, however, should prevent so many failures due to poor hunches and guesses, quick fixes, and applying the fad of the day.

MANAGEMENT SCIENCE VS. SCIENTIFIC MANAGEMENT

In these days of intense global and national competition, there is a greater need for Scientific Management. Largely due to the conditions covered in Chapter VI of this report, managers, executives, administrators, authors, and others have not been adequately taught THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14). Knowledge and use of this is needed for better scientific management.

When you do too much "seat of the pants" management, you may end up getting kicked out of a job! Actually, SM-14 is the same formula and guide that talented people use intuitively, in varying degrees. More effective leadership and competitiveness will result, though, from teaching it to everyone.

To better understand Management Science, remember that it is an inexact science.

Concluding hypotheses in such an inexact social science may be described like this:

- An educated guess by human beings about knowledge of things and humans (this should not be called a truth, fact, perfection, law, or proven theory)
- One where we strive for: **Accuracy—Correctness—Exactness**
- One resulting in a high degree of: **Plausibility—Probability—Practicability**

Therefore, we suspend judgment and keep an open mind.

The condensed explanation below is an initial effort to clear up misunderstandings and misconceptions.

Management Science

This is our basic body of management-related knowledge usually accumulated through the use of parts or all of SM-14. While some of this knowledge will still be theoretical, most will have been added after actual testing and experience, and challenge and acceptance (to some degree), by members of the management profession.

However, the challenge and acceptance procedures in the management field have not been as highly used and organized as in the physical sciences. Thus, this knowledge must be viewed with more skepticism, especially in view of the concepts being educated guesses usually involving human beings. The teaching and use of SM-14 to refine and extend our body of knowledge through problem origination, prevention, solution, and challenge of solution will greatly increase its Plausibility, Probability, and Practicability.

SUSPEND JUDGMENT—KEEP AN OPEN MIND

Scientific Management

This is the application of our body of management and general knowledge using part or all of SM-14 in a flexible manner. We must continually define and look at the systematic view or big picture of management sciences. The use of the fourteen guiding ingredients of SM-14 is supported and supplemented by such things as:

- Actual experience
- Team work
- Trial and error
- Risk taking
- Constant use of curious observation
- Consultations with those affected
- Intelligent compromise in human relationships

In the course of this activity, our body of knowledge is constantly refined, extended, and adapted to changing or unusual conditions, as called for by the various ingredients of SM-14.

SUSPEND JUDGMENT—KEEP AN OPEN MIND

Intelligent compromises often needed—not only in business, but in all social sciences.
Davis, in *The Fundamentals of Top Management* (1979), states:

> It was suggested previously that "intelligent compromise" should be considered a phase of the scientific method when applied to business planning. Management is becoming a profession. It is not based directly on the "exact" physical sciences, however. The "one best method," insofar as the field of management is concerned, is the one that will get the most results of the requisite quality for the least money, and have them available when and where they are needed. It is not usually the method that is theoretically perfect. It is more likely to represent some compromise between complexity and scientific accuracy on the one hand, and simplicity, understanding and cooperation on the other. It may be modified in an attempt to adjust legitimately the personal interests of personnel to the service objectives of the organization. Plans do not execute themselves. They must be executed by the organization's personnel.

SM-14 HAS BEEN THE MISSING DIMENSION IN TEACHING MANAGEMENT

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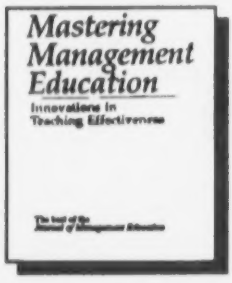
SCIENTIFIC MANAGEMENT NEEDS SM-14



The foreword in this 1993 book, written by Professor David L. Bradford (Stanford University), stresses that change will force faculties to switch from just imparting answers to passive learners to instilling the desire to generate knowledge while continuing to learn:

. . . if our "knowledge" will become quickly outdated (if it hasn't already) [1], then we need to do more than teach the facts from research studies [2]. Most important will be teaching learners how they can continue to learn [3]. The process of learning how to problem solve may be more important than the specific answer itself. Furthermore, rather than their automatically accepting the validity of what we impart, students need knowledge in how to test the validity of new knowledge that they will soon have to face [4]. Finally, they will increasingly need the ability to generate knowledge on their own [5].

[1] Page 7 of this report calls attention to the fast pace of knowledge doubling.

[2] SM-14 is the basic method by which we refine, extend, and apply knowledge.

[3] Usually we do this through problem origination, prevention, solution, and challenge of solution—using SM-14 as a guide. Under these ingredients, by utilizing thinking skills, we use creative, logical, and technical methods and processes for actually accomplishing results.

[4] SM-14 is the method for refining and challenging concepts (using all 14 ingredients—especially Ingredient #8).

[5] Curious Observation (SM-14's Ingredient #1) is the beginning of generating new or refining existing knowledge.

SM-14 IS THE ONE METHOD OR GUIDE WHICH COVERS THEM ALL

Since decision making is studied and used so much, it is especially important to remember that a decision is a *decision problem* or a *problem decision*. Some of the most common actions and activities related to management:

Decision Making	Investigative Reports	Systems Analysis	Inquiry
Problem Solving	Operation Research	Planning	Inventing

Nobel Laureate Herbert Simon states, "scientific discovery is a form of problem solving and the decision-making processes are essentially the same as problem-solving processes."

The application of this simple similarity and SM-14 can save billions of educational dollars—with probably even greater savings in management costs. It can even result in increasing our gross national product by billions of dollars. If you question this estimate of savings, challenge it through research—apply SM-14 to the challenge!

IMPORTANT TO REMEMBER—ONE METHOD COVERS THEM ALL

Teaching & Recognition of "The Scientific Method" in the Management Field

The misunderstandings about "The Scientific Method" have taken their toll in management literature. Many management books do not even mention it. However, I did find a few authors (in a survey of about 100 books) who recognized the need for the method and the general nature of "The Scientific Method." As usual, the formulas they presented varied, with no standardization. The following books, to their credit, do cover (to some extent) the use of "The Scientific Method."

Meson, et al (1981), *Management: Individual and Organizational Effectiveness*
Davis (1979), *The Fundamentals of Top Management*
Lee (1983), *Introduction to Management Science*
Browne (1984), *Management Analysis of Service Operations*
McCarthy & Perreault (1987), *Basic Marketing: A Managerial Approach*
Schermerthorn (1984), *Management for Productivity*
Sampson, et al (1972), *The American Economy—Analysis-Issues-Principles*
Maynard (1970), *Handbook of Business Administration*
Certo (1980), *Principles of Modern Management*

AMERICAN MANAGERS AND GLOBAL COMPETITION

During the last few years, we have had numerous articles and books (written by such authors as Drucker, Cetera, Marshal & Tucker, Perelman, Koch, London, and Hammer & Champy) indicating that many American managers are not meeting global competition. What can be done to improve this situation? Ingredient #1 of THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14), with comments, is a starting point.

Reprinted below is Page 5, Ingredient #1, from *THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)* Student Booklet. Remember, today you must be a student for life!

COMMENTS

PART I—Origination
The Context of Discovery—The Inductive Process
(Ingredient #1)
CURIOUS OBSERVATION **(1)**

Managers must exercise more curiosity, especially concerning change!

Curious observation is the start of the inductive process. Discovery of new problems, ideas, theories, decisions needed, and problem prevention usually begin with curious observation using the five senses: *smelling—tasting— hearing—feeling—seeing*.
Instruments and tools can be used to help extend these senses.

More imagination and reflective thinking is needed!

Use your sense perceptions and projections—visually and mentally. Turn thoughts over and over in your mind. Use reasoning, *your imagination*, and introspection. Being in the right mood, motivated, and sensitive helps! Train your mind to interpret what you see.

Managers need to adequately learn SM-14 with its Problem Origination and Discovery.

Where does problem origination or discovery begin?
The answer is "no one place." Some of the more typical instances are:
1. Things you feel might fill a need—or that irritate or perplex you.
2. Previous experience—You have some thing or theory to investigate.
3. Need project—Looking or brainstorming for problems or fields to investigate.
4. Triggered interest—You decide to investigate as a result of surprise, chance, accidental discovery, observation, illumination, serendipity, reading, experimenting, reflective thinking, or clue. It may also result from a combination of events and things.
5. Assigned, suggested, or thrust—A specific problem or field to pursue.
6. Recognition of potential trouble—Preventive investigation required.
7. Solution of one problem—often reveals other problems.

Need to be able to spot potential trouble *sooner*.

Managers need better education and training in these skills.

What should you be seeking and be sensitive to?
1. Any of the above. Stay alert. Develop recognition skills. Be persistent.
2. Problems worthy of solution, practical to investigate new fertile fields.
3. Ordinary things to be examined in a new way and with new meaning.
4.

Curiosities	Relationships	Experiments needed	Leads
Differences	Disturbances	Unexpected failures	Challenges
Similarities	Intimations	Problematic situations	Surprises
Patterns	Unusual results	"Thorns in flesh"	Opportunities
Obstacles	Comparisons	Listen to others	Suppositions

Curious observation also involves other thinking skills, a few of which are:

Evaluating	Visualizing	Imagining	Classifying	Abstracting
Planning	Describing	Questioning	Computing	Communicating
Judging	Interpreting	Conjecturing	Inferring	Measuring

More alertness and less complacency needed!

Perpetual innovation is needed!

More reading is needed to keep abreast of and originate new ideas to stay ahead of the competition.

Develop the attribute of curiosity—you use it throughout SM-14.
1. Constantly observe—Ask questions—What, Why, Which, Where, When, Who, How, and If. Visualize what might be. Accept nothing as "fact."
2. Be an innovator—Cultivate curiosity to find ideas. See Pages 13 & 35.
3. Read, skip, and skim publications for data, ideas, and triggers for ideas.

Having found something, continue on now and define the problem. If necessary, gather more information before trying to define the problem. Any solutions you derive, no matter how good, should be considered tentative.

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RECOMMENDATIONS TO MANAGEMENT

Although these pages on management have been directed mainly toward business and industry managers, they actually apply to all managers in all fields and at all levels. Here are some recommendations based on five years of researching "The Scientific Method."

RECOMMENDATION #1: Take action now to improve the quality of your future job applicants. Request that schools teach SM-14 across the curricula.

Business, Industry, and Professional Leaders	**Educators are trying to respond, but:**
You have expressed concern with the quality of job applicants. In surveys and school reform reports, you have requested applicants who are: ■ problem solvers ■ more creative ■ better thinkers ■ more trainable ■ capable of filling higher-skilled jobs ■ constantly developing better personal attributes	■ are still claiming (in most cases) that "The Scientific Method" does not exist ■ have no standardization of thinking skills programs ■ are not adopting SM-14 ■ are being seriously hampered by some vocal parents who misunderstand your needs and condemn *all* outcome-based education programs because of worry about a *small part* concerning values

Recommend Immediate Action

■ Write to those responsible for education as listed on Page 39 (#9). Ask that they investigate and thoroughly study SM-14, as it answers your requests for better job applicants.

■ Ask your legislative representatives to include SM-14 in their school reform legislation.

■ If spending corporate funds to aid educational projects, ask that SM-14 be thoroughly investigated.

■ Support educators who are trying to bring you better applicants through outcome-based education. Intelligent compromise may be necessary on the "values" issue.

RECOMMENDATION #2: Management should incorporate SM-14 into internal operations, planning, decision making, problem solving, research, training programs, etc.

Ask for studies

You are respectfully requested *not* to ask others for their opinion of SM-14 . . . **ask for studies!** As shown in this booklet (for reasons explained in Chapter VI), even our leading management consultants, authors,
professors, executives, etc. have not been adequately educated in "The Scientific Method."

Standardize on SM-14

Your current training programs are probably using no knowledge formulas or, at best, a variety of incomplete ones. Standardize on SM-14 to save money and increase effectiveness of your programs.

Everyone in your organization needs SM-14

From the top of the corporate ladder to the bottom . . . SM-14 is needed! It may be difficult to have everyone attend training classes, etc. So encourage and reward those who have a self-improvement plan that includes learning SM-14.

Reports should follow the SM-14 format

There are always very important decisions to make and problems to solve. Make sure that your personnel uses the guiding ingredients of SM-14 to prepare and submit their reports.

Self-challenging of hypotheses should be encouraged

Most people submit a lot of supporting evidence for their conclusions, without reporting unconfirming evidence or trying to falsify their conclusions. Ingredient #8 of SM-14 encourages challenge of the hypothesis before submission or publication. (Of course, watch out for that "can't be done" person.)

SM-14 is a complete guide

Don't forget that SM-14 is a complete guide. It covers problem origination, prevention, solution, and challenge of solution. It even includes *Suspension of Judgment* to promote open-mindedness and continuous generating of alternatives.

CHAPTER IV
IDEAS AND RECOMMENDATIONS FOR TEACHING SM-14

STATUS OF TEACHING "THE SCIENTIFIC METHOD" IN 1994

Science Classes K-12	Some, *but not all*, science textbooks mention "The Scientific Method." However, this usually amounts to only a few pages, with little or no continuation of the theme. (The chart and formulas on the next page will give you a partial picture.)
Other Subject Classes and Extra-Curricular Activities K-12	Nearly no other subject areas include the teaching of "The Scientific Method." A few schools currently offer Creative Problem Solving classes and/or extra-curricular activities which include a formula for this. It is usually the one recommended by the Creative Education Foundation, which is a good formula—but not as complete as SM-14.
Thinking Skills Movement K-12	In a recent survey of 33 teaching programs which stress thinking skills, ***not one*** included "The Scientific Method." Surprisingly, only about 10% of these included a problem-solving formula. Why? Is this a result of the denial of the existence of "The Scientific Method"?
National, State, and Private School Reform & Restructure Programs K-12	Tragically, research shows none that include the teaching of "The Scientific Method." (See Chapter VI of this report for complete information.)
Foundation, Business, Professional, etc. School Reform Reports	Over 300 reports have been issued in recent years by important organizations. A great many have stated the need to teach problem solving, creativity, and thinking skills. Educators should respond by teaching SM-14, as it is easily applied to all of these.
Colleges and Universities	***Management and Case Method Classes*** Even though "The Scientific Method" is the base for applying Scientific Management and the case method, only a few books and classes teach a formula for its use. Decision Making is frequently taught with a variety of formulas. ***Problem Solving & Creative Problem Solving Classes*** There are a number of schools that now offer this type of class. ***Science Classes*** This situation is similar to K-12 science classes (see above). The next page offers examples of some college textbook formulas.

There is a small undercurrent of change moving through our teaching systems which occasionally offers a breath of hope . . .

- ✔ The International Science & Engineering Fairs' revised rules recommend that participants use the scientific method.
- ✔ Some authors and textbook publishers are beginning to devote more space to the subject, including supplementary workbooks.
- ✔ The *Teach Thinking Skills Movement* is growing but needs to be standardized with SM-14.

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REVIEW OF CURRENT TEXTBOOKS COVERING "THE SCIENTIFIC METHOD"

We should all salute the textbook authors and publishers who have included a formula for "The Scientific Method." During the decades that the controversies have existed, these have been the principal source for any knowledge which students have obtained. Formulas that appear in the various textbooks vary a great deal. To illustrate this, but not to criticize, some formulas are shown below, exactly as they appear in current textbooks.

ELEMENTARY SCHOOLS
Steps of a scientific method:

- Identifying a problem.
- Gathering data (facts and observations).
- Form a hypothesis.
- Perform experiments to test hypothesis.
- Form conclusions (from results of experiments).

Four key processes of the scientific method:

1. Observation (begins with curiosity). Find out what is known about the subject.
2. Form a hypothesis (based on observations and research).
3. Experiment to test hypothesis.
4. Make a conclusion (a statement of whether or not experimental data supports the hypothesis).

SECONDARY SCHOOL
A Scientific method:

- Defining the problem.
- Collecting Background Information.
- Formulating a Hypothesis.
- Testing the Hypothesis.
- Making and Recording Observations.
- Drawing Conclusions.

Guides to scientific methods:

- State the problem. Inquiry begins as a result of observation.
- Gather information. (Includes measurement.)
- Form hypothesis (after problem is stated and information gathered).
- Test the hypothesis (by experimentation).
- State a conclusion.

COLLEGE
Scientific Method:

- Observation. (1st step).
- Generalize about observations: inductive reasoning.
- Make statement: hypothesis.
- Deduce consequences of hypothesis and make prediction about future observations: deductive reasoning.
- Test prediction of hypothesis by experiments.
- Hypothesis becomes theory if supported by a great deal of data.

Steps in scientific method:

1. Making careful observations.
2. Formulating one or more explanations (hypotheses) to account for the observation.
3. Designing and conducting experiments to determine if hypothesis is correct.
4. Analyzing results and drawing conclusions.
5. Accepting, rejecting, or modifying a hypothesis to be consistent with the results of experiments.
6. Sharing results with other scientists.

Survey of Some of the Most Current Textbooks in Edmund's Library Referencing "The Scientific Method"

Book #	Textbook Name	©	Publisher	#*	Exact Terminology Used
4-182	Problem Solving Science Investigations	1989	Teacher Created Materials, Inc.	1	SCIENTIFIC METHOD
4-196	Chemistry (TE)	1987	Addison-Wesley	1	The scientific method
4-103	Life Sciences—Challenge of Discovery	1991	Heath	7	The Scientific Method
4-104	Essentials of Biology	1990	McGraw-Hill	2	**scientific method**
4-116	Life Science	1989	MacMillan	15	The scientific method
4-117	Physical Science	1991	Prentice-Hall	25	**scientific method**
4-119	Biology of Animals—5th Edition	1990	Times-Mirror	2	the scientific method
4-135	Chemistry—2nd Edition	1989	Heath	33	**SCIENTIFIC METHOD**
4-136	Biology	1989	Brown	14	**scientific method**
4-137	Biology: Life on Earth	1989	MacMillan	4	*scientific method*
4-84	Biology (TE)	1990	Globe	15	Scientific Method
4-83	Modern Earth Science (TE)	1989	Holt-Rinehart	10	scientific methods
4-80	Earth Science (TE)	1990	Globe	15	The Scientific Method
4-77	Life Science	1987	Heath	10	scientific method
4-76	Life Science	1990	Silver Burdett & Ginn	4	**scientific method**

*Approximate number of pages and comments concerning "The Scientific Method"

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THINKING SKILLS TEACHING MOVEMENT — 1994

Out they come . . . but not fully prepared for this fast-changing, competitive world!

Educators have a tremendously important movement underway—the teaching of thinking skills. The results of this effort could eventually add billions (and even trillions) of dollars to our gross national product through increased creativity, innovation, production, new products; and more efficient problem solving. This movement is fueled by a group of progressive educators.

Many authoritative individuals in government, general public, and media (and publishers of reform and restructure reports) don't seem to realize the importance of the thinking skills movement.

TEACHING OF THINKING SKILLS IN OUR SCHOOLS TODAY

Employers— receive inadequately educated students.

Colleges— receive students from numerous schools with inadequate training in thinking skills. Professors must then teach basic skills before teaching subject matter.

- No thinking skills program taught in the majority of schools.
- Some teachers make a valiant, unsupported effort to teach thinking skills in their classes.
- Locally designed thinking skills programs taught in some schools.
- Some local groups claim that school's only purpose is to teach academic subjects.
- A number of nationally available programs are being taught, which are sponsored by various individuals, organizations, corporation, or schools. These vary widely and, in most cases, are designed only for certain grades.
- Only a small number of school systems have a planned program of teaching thinking skills in all grades.

RECOMMENDATION

We must develop a standard program for teaching thinking skills in all grades and across the curricula. The base for this should be THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14), or similar, since the major reason for thinking is related to problem solving. This standardized program should have the features included in the concept of the plan presented on Pages 32 and 33.

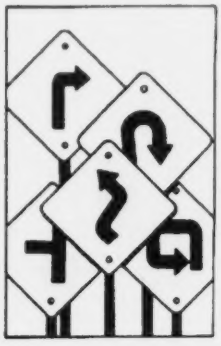
To be a world leader, the USA must have a standard, but flexible, program for teaching thinking skills!

STANDARDIZING ON SM-14 (OR SIMILAR)

RECOMMENDATION: Educators should standardize on the 14 ingredients, the name, and terminology of SM-14 (or similar).

With the current knowledge and information explosion, as well as global competition, the need increases every day to standardize on the basic guide or method that we use in refining, extending, and applying knowledge. To continue to teach no guide, or hundreds of different ones, is extremely wasteful and harms our global competitiveness and educational efforts; thus, our welfare suffers. This report points out the many (but not all) fields covered by SM-14 and the advantages of using such a guide.

In an era of change such as we are experiencing, there can be danger to standardization. However, "The Scientific Method" has gradually developed over the centuries. Since I researched so many formulas for it, the one proposed should endure for many years. Therefore, it deserves serious consideration. My library and files are open to anyone who is designated to set the standards.

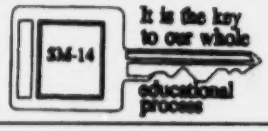


Standardization Should Not Interfere with Flexibility

- The terminology of the ingredient names is so general that SM-14 fits all domains and can be taught across the curricula.
- If teachers want additional ingredients, they may insert them by numbering them 2A or 7A, etc.
- As I have stressed, these ingredients can be used in any order which actual practice requires. No rigid "steps" or straight paths are involved. You may change direction, backtrack, twist, dead-end, loop, detour, etc.
- Teachers may add words to ingredient terminology (e.g., Ingredient #11 could become "Action Plus Reporting and Winning Acceptance."
- The methods, processes, etc. used under the ingredients can vary to suit the problem or domain being subjected to SM-14. Recommendations are made on *some* standardization regarding these (see Page 33), but SM-14 is flexible.

YOU MUST STANDARDIZE ON SM-14 BEFORE SETTING SUBJECT STANDARDS!

- Before standards are set for individual subjects, you must set standards for what should be taught across the curricula so that there can be coordination in all standard programs (see next page). Doing this is of great national importance and deserves top priority!



Standardization in business, industry, professions, etc. must be coordinated with standardization in the school field. On Page 26, I recommend to management of various organizations that they standardize on SM-14 throughout their organization. It is not logical to teach one formula in schools and another in industry and business. Therefore, there must be coordination on the standardization of the SM-14 formula (or similar).

Teacher's Problems are Inadequately Understood

When you try to look at the big picture on reforms, changes, student mix, future technologies, etc., it is hard to imagine how teachers are going to manage. In the April 1994 issue of *Educational Leadership*, John Driscoll states: *"... few who haven't taught for a sustained period have any appreciation for the amount of time and energy that must be devoted to accounting for students and delivering instructions, and consequently how little time is available to do anything else. Training for technology simply can't be done on the fly or after hours."*

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THE GOLDEN FORMULA SHOULD BE TAUGHT ACROSS THE CURRICULA

With knowledge doubling at an ever-increasing rate, we have no choice but to teach the *Golden Formula*. There is even a frightening forecast that knowledge will double every 73 days by the year 2020 . . . and that is only a few years away!

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) is the basic method or guide by which we refine, extend, and apply knowledge in all fields—through problem origination, prevention, solution, and challenge of solution. This *Golden Formula* should be taught across the curricula in all grades. Elsewhere, I have shown how essential it is in the teaching of:

Science	Mathematics	Methods	Research
Technology	Personal Life	Inventing	Management
Innovation	Creativity	Discovery Teaching	Inquiry Teaching

The Student Portfolio and Alternate Assessment Movement
Teaching of All Types of Thinking Skills (low, high, critical)
How to Access Information through the Digital Information SuperHighway (DISH)

Here is how SM-14 relates to other curricula subjects . . .

Importance to the teaching of English and Languages

Early in my research, I wondered how SM-14 could aid in the teaching of English. Then a business associate complained that while his staff could read, they seemed to have trouble comprehending what they had been reading—AHA! To comprehend what you read and to write effectively, you must be educated and trained in problem origination, prevention, solution, and challenge of solution. You must know what concepts are, be able to spot them, and abstract the reasoning and principle thoughts which have been expressed.

Then, a chart came in from The Council for Basic Education. Under their vision of what ENGLISH STANDARDS should be, point three states: "Engage in fluent, responsible speech and writing; analyze, classify, compare, formulate hypotheses, make inferences, draw conclusions from information at school and in the world; and solve problems, both rationally and intuitively." This is a close description of THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

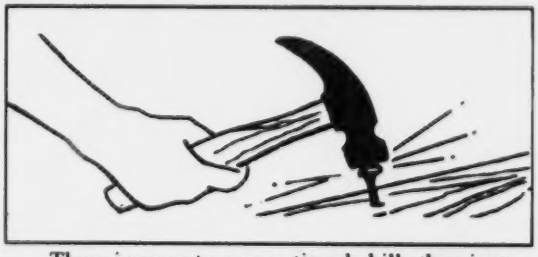
There is also now a movement to teach students to "write across the curricula." This involves putting their thinking, research, problem solutions, portfolios, etc. into writing. SM-14 is a valuable tool and guide in all subject areas. Thus, it should be taught as part of English and foreign language courses from K to 16.

Importance to the teaching of Geography, History, Social Studies (Civics), and The Arts

Again, visions listed by The Council for Basic Education (as to what the standards should be for these subjects) were the type that would require THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

Important to Vocational Education

Gene Bottoms, Director of High Schools That Work, in discussing reform principle for vocational education, states: "Simply knowing how to perform a routine task is not enough in today's increasingly complex workplace. Career-bound students need math, science, language arts, technical, and problem-solving competencies to get and hold a good job."



There is more to occupational skills than just knowledge and . . . "hitting the nail on the head!"

Be sure to read Pages 38 and 39 in the SM-14 Student Booklet.

The reason for thinking is problem origination, prevention, solution, and challenge of solution!

PROPOSED CONCEPT OF A PLAN FOR TEACHING SM-14

Having advanced the hypothesis that SM-14 should be taught across the curricula, I realize that this is a major change from the present subject-oriented curricula and may raise problems. A major concern is that teachers have not been trained to teach SM-14, the thinking skills, and the methods and processes involved in problem origination, prevention, solution, and challenge of solution.

Here, I present a concept of a plan for teaching SM-14. Please remember that this is a *concept*—not a plan. It is theoretical and represents ideas that need development based on some general principles.

It must:

(1) be a KISS program—Keep It Student Simple;

(2) be computer and multi-media compatible;

(3) make it clear to all students that SM-14 will prepare them for everyday life and future careers;

(4) avoid burdening teachers and students with complicated philosophical and technical concepts;

(5) have standardized features for teaching across the curricula, nationwide, in all grades and subjects;

(6) encourage professional organizations and commercial concerns to offer supporting materials;

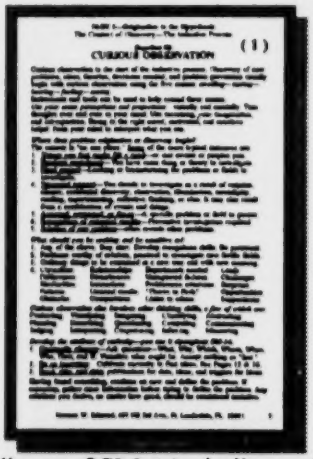
(7) be designed with these features in mind, in order for teachers to teach SM-14 without extensive re-training:

- (a) a standardized format that can be studied and reviewed shortly before presenting to students;
- (b) 8½x11 sheets in a three-ring binder, to allow for changes;
- (c) discussion-type teaching to lessen the teacher's burden and promote student interest;
- (d) team teaching and coordination between domains made easy.

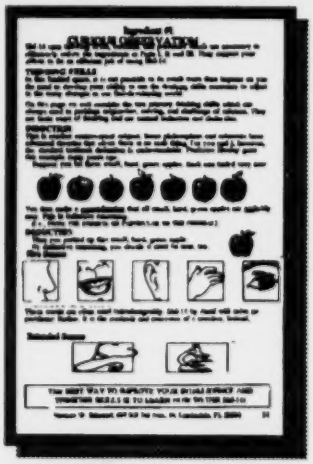
STUDENT'S PERSONAL SM-14 NOTEBOOK

Students would start with one 8½x11 loose-leaf notebook. This would expand into a series of notebooks as the student progresses through grades, to be used for both learning and review.

SECTION A—INGREDIENTS OF SM-14



Ingredients of SM-14, similar to Student Booklet, except it would be 8½x11 in size



Supplemental, illustrated sheets for each ingredient

THE FORECAST IS THAT TEACHERS WILL BE FACILITATORS AND COORDINATORS

Teacher training will never be able to keep up with the fast pace of change and reform programs. Thus, the concept of Point #7 (see list above) is going to have to be used more often.

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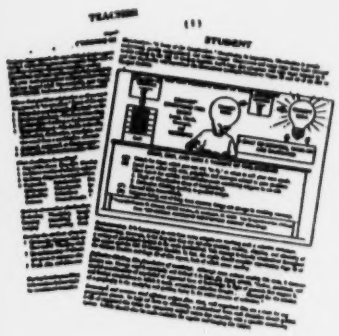
PROPOSED PLAN CONCEPT *(continued)*



Section B: Thinking Skills—All Types
8½x11 looseleaf sheets for the most used thinking skills, with supplements prepared when necessary. One series for students and matching ones for teachers.

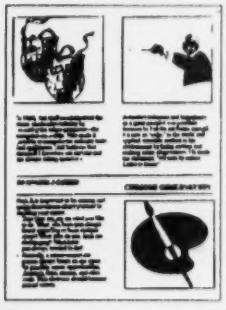
The February issue of *Learning 90* magazine showed an excellent sample of a thinking skills series of 8½x11 sheets prepared for teachers by Dr. Deborah Burns of the University of Connecticut.

Section C: Methods and Processes Used under SM-14 Ingredients
It is often difficult to classify what is a thinking skill and what is a method or process, a study could standardize this, however, and recommend those most often used and most important.

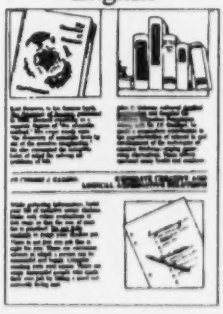
The preparation in 8½x11 looseleaf form makes review and change easy. It is easily scanned for use on a computer and in multi-media presentations. This is especially important as the number of sheets increases and computers become more plentiful.

Section D: Specific Subject Areas from The Arts to Zoology
Each domain, in addition to aiding in teaching general thinking skills and methods, would teach special skills and methods peculiar or especially important to their field.

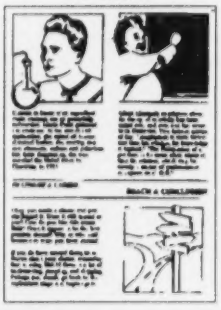
The Arts



English



Science



Other Domains

Other Sections of Notebooks (may be varied and personalized)

- My Personal Achievement Portfolio
  - Based on Problem Origination
  - Prevention
  - Solution
  - &
  - the Challenge
  - of the Solution

- INFORMATION SOURCES
  - How to find Information and Existing Knowledge
  - &
  - Up-To-Date List of Sources and Information
  - Technologies

- My Personal Self-Improvement Plan
  - Including Values to be Learned Under Parental Guidance

Student Abilities and Motivation Sets Pace of Learning
This concept of a plan would call for frequent application of SM-14 by students. Those who have the ability or motivation to exceed any standards of achievement could easily be provided for by allowing them to originate more difficult problems to solve and/or an expanded series of skills and methods.

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CHAPTER V
MORE INFORMATION ABOUT "THE SCIENTIFIC METHOD"

THE EVOLUTION OF "The Scientific Method"

Other Names for "The Scientific Method"

Over the centuries, countless names have been used for what is basically "The Scientific Method." These are just some of the names:

Method of discovery
Method of inquiry
Process of inquiry
Experimental method
Pattern of scientific investigation
Operation research
Way of knowing
Scientific research
Reflective inquiry
Method of study
Process of search
General pattern of research
General approach for gathering information
Scientific investigation
Research method
Processes of science
Key processes of scientific method
Scientific procedure
Processes of discovery
Art of experimental research
Pattern of investigation
Experimental inquiry
Critical evaluation
Procedures of scientific inquiry
Scholarly investigation
Method of reason
Patterns of thought
Genesis of scientific method
Art of investigation
Scientific approach
Scientific research method
Habits of mind
Ways of a scientist
Technique of scientific method
Scientific method of inquiry
Tool of inquiry
Research methodology
Scientific mode of thought
Reflective inquiry
Method of study
The scientific pattern of thought

It has been stated that "the greatest discovery in science was the discovery of the scientific method of discovery."

This method is most often called The Scientific Method, a Scientific Method, and Scientific Method. Actually, it was a method that evolved slowly over the centuries. Numerous formulas were proposed. There were debates, discussions, meetings, papers presented, philosophical theories expounded, and much literature published. Even today, our leading scholars are still arguing as to what it is. Some are going so far as to claim that it does not exist—basically because of the misunderstandings of "The Scientific Method" that are covered in Chapter VI of this booklet. In this age of knowledge, it is highly desirable (in fact, a necessity for teaching purposes) to standardize on one formula and one name for this method.

THE CHOICE OF A STANDARD NAME

Because of the misunderstandings about "The Scientific Method," I have used the names THE GENERAL PATTERN OF THE SCIENTIFIC METHOD and SM-14 to identify the recommended formula. I started off with The Scientific Method, then The General Scientific Method, then The Universal Scientific Method. When I realized the extent of the controversies concerning its existence and the need for flexibility, I finally decided on THE GENERAL PATTERN OF THE SCIENTIFIC METHOD.

Gaining acceptance for SM-14 would probably be easier if I had used the term, "The General Pattern of Problem Solving." But the term problem solving doesn't indicate origination, prevention, or challenge. "The General Pattern of Problem Originating and Solving" *could* have been used with "challenge" understood. Another good name that has been used is "The Scientific Approach." Whoever undertakes an official standardization of the formula should also standardize on a name.

WHAT SHOULD WE CALL THE "ELEMENTS" OF SM-14?

The words "steps" and "rules" have often been used in the past. As these terms indicate set and inflexible procedures, they cause misunderstandings. Some other terms that have been used:

Ingredients	Procedures	Thought Processes	Elements
Operations	Phases	Recommendations	Routines
Stages	Principles	Techniques	Guides
Strategies	Tactics	Processes	Methods

I followed Dr. Crooks' suggestion and used the term **Ingredients** to refer to the fourteen elements in SM-14.

There are times when it is convenient to use a term other than "ingredient." At those times, the better words to use are:

ELEMENTS PHASES GUIDES STAGES PROCESSES

Ill-structured problems are all ill-defined in their own way. You never know what you will run into. Flexibility is essential. The title words, "General Pattern," better reflect actual practice.

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FLEXIBILITY OF USE OF INGREDIENTS & METHODS UNDER INGREDIENTS

Some Factors Which Make Flexibility Essential

Complexity of problem
Conflicting data
Time limitations
Individual techniques
Budget restrictions
Change in plans/goals
Team problem solving
Redefinition of problem
Professional ethics
Problems within problems
Ill-structured problems
Accessibility of information
Availability of facilities
Diversion to sub-problems
Institutional regulations
Social/environmental concerns
New opportunities
Prior experience
No results—retest
Constraints
New observations
Lack of equipment
Surprise discoveries
Creative thought
New insights
Competition
Need to publish

Frequently, a problem or decision must be broken down into many different levels of sub-problems before proceeding.

Problem—Many objections to "The Scientific Method" were caused by the hundreds of incomplete formulas offered for it and the use of the words "steps and rules." It was seldom clarified that these could be used in a flexible order.

Solution—It must be realized and taught that, in actual practice and use, the ingredients will not always follow in sequential step or rule order. The term *usual order* is preferred over *logical order.* The necessity of flexible use of the ingredients is demonstrated by the following occurrences, which often happen in actual practice:

Detours	Branching	Coiling	Accidental discoveries
Interacting	Dead ends	Back-tracking	Concurrent use
Interfacing	Feedback	Extended use	Illogical attempts
Jumping	Looping	False hypothesis	Inter-playing
Misdirection	Pausing	False starts	Partial completion
Overlapping	Reversing	Recursions	Working backward
Skipping	Stalling	Time not ripe	Spurts of success
Turning	Surprises	Slow advances	Simultaneous use
Twisting	Termination	Train of thought	Work on several phases

Run parallel & interweaving courses Temporary setbacks or successes

Classification of Methods, Processes, etc. Used Under the Ingredients

Essentials of Scientific Method, Wolf (1925), classifies them as logical and technical, with imagination under logical. He states that technical ones are manipulation and measuring, and mainly auxiliary to logical methods. In order to stress creativity, I made a separate classification for it.

As previously mentioned, SM-14 will not, in itself, solve any problems. It is the action taken under the ingredients that produces results. Historically, the most common term used for these actions has been "methods."

While we should not use the words "steps" or "rules" in referring to the use of SM-14 ingredients, there is no objection to their use in describing some procedures used *under the ingredients.* Some terms frequently used for actions under the ingredients are:

Methods	Techniques	Strategies	Operations
Steps	Process Skills	Principles	Routines
Tactics	Thinking Skills	Rules	Guides
Systems	Approaches	Programs	Processes
Skills	Procedures	Deduction	Creativity

In decision-making problems, the word "criteria" is used for specifying standards which are applied in reaching a decision.

IT'S A "FACT" . . . IT'S "TRUE"

Most "facts" or "truths" are only data, information, or knowledge which may be right, wrong, or any shade thereof. When using these words, consider putting quotes around them.

In using SM-14, instead of looking for "facts" and "truths," keep an open mind and strive for:

ACCURACY—CORRECTNESS—EXACTNESS (**ACE**)

PLAUSIBILITY—PROBABILITY—PRACTICABILITY (**3 P's**)

A TRIBUTE TO PROFESSOR KENNETH B.M. CROOKS

Dr. Kenneth B.M. Crooks' "Suggestions for Teaching the Scientific Method" was published in the March 1961 issue of "American Biology Teacher," resulting in my eventual writing of the SM-14 Student Booklet. After five years of searching hundreds of old and new books, I found no other description of "The Scientific Method" as clear, concise, or teachable as Professor Crooks'. His insight into the method (when others were on the wrong path) is impressive. The SM-14 booklet is dedicated to him and the many others who have aided in the development of "The Scientific Method" over the centuries.

Born May 25, 1905, in Hanover, Jamaica, British West Indies, Dr. Crooks earned his B.A (1927), M.A. (1928), and PhD (1940) at Harvard (where he studied chemistry under Dr. Conant). He became a full professor at Hampton Institute in Virginia, was elected a Fellow in the American Association for the Advancement of Science, was a member of many professional organizations, and published over thirty papers.

Personal: Married Nella Edgar in 1929. Professor Crooks was a minister in the Religious Society of Friends (Quakers).
Children: Cynthia C. Carpenter, Kenneth B.M. Crooks, Jr., Sylvia C. Wunderlich, and Nella C. Jenkins.

On June 20, 1933, Dr. Crooks spoke of "The Scientific Method" on WGH Radio in Norfolk, Virginia. In December 1958, he presented a paper, "Suggestions for Teaching the Scientific Method" at the National Association of Biology Teachers' annual meeting with the American Association for the Advancement of Science. Even though he became ill a few days before presenting his paper, he insisted on giving his speech. He returned home to Grambling, Louisiana, and died a few days later. Dr. Crooks' career would make an interesting documentary or movie. He should be held up as a role model.

In 1974, his scientific publication papers and memorabilia were placed in the Armistad Research Center at Tulane University in New Orleans, Louisiana, by his family.

Dr. Crooks' ten ingredients for teaching "The Scientific Method" were:

1. Curiosity
2. Is There A Problem?
3. Get the Evidence
4. Attributes Needed
5. Weigh All Evidence
6. Make the Educated Guess (Hypothesis)
7. Challenge the Hypothesis
8. Get A Conclusion
9. Suspend Judgment
10. Deductive Reasoning

NOTE

The following are available from his widow, Nella Crooks, and son, Kenneth B.M. Crooks, Jr.:

- **Dr. Crooks' paper as it appeared in the March 1961 issue of American Biology Teacher. It has some excellent information on the use of "The Scientific Method" in the classroom and for writing a report and is highly recommended to educational researchers and anyone interested in the subject. Mrs. Crooks and her family have granted use of this article to anyone who wishes to use part of it or to reprint it completely. Price: $5.00.**
- In 1989, at the age of 88, Mrs. Nella E. Crooks, who earned a master's degree (1963) in Guidance and Counseling, wrote a thirty-page biography of Dr. Crooks. Price: $10.00.
- In 1993, at the age of 92, Mrs. Crooks wrote her autobiography. Price: $21.45

Send requests and payment to: Crooks Enterprises
P.O. Box 1075
Fort Valley, GA 31030-1075

CHAPTER VI
MISUNDERSTANDINGS, MISINTERPRETATIONS, AND CONTROVERSIES CONCERNING "THE SCIENTIFIC METHOD"

Some interpret "Method" in "The Scientific Method" to mean that it is a method, in itself, that will solve problems. Actually, in this case, method only means that it is a guide.

Dewey, in *How We Think* (1933), states, "Method consists of a set of operations by which the machinery of thought is set going and kept at work on any subject."

HOW CAN "THE SCIENTIFIC METHOD" NOT EXIST?

A mass of supporting evidence indicates that "The Scientific Method" does exist

There have been thousands of books and papers—written by distinguished and famous figures in the fields of education, science, research, psychology, and philosophy—claiming or citing the existence of "The Scientific Method." Many called it by another name (e.g., Method of Discovery, Method of Inquiry, Method of Invention, Method of Research), but they were all referring to the same method or guide. A review of of over 1,000 books mentioning the subject produced more than 300 different versions of "The Scientific Method." It all adds up to a substantial body of knowledge supporting its existence.

So . . . how can "The Scientific Method" not exist?

Problem Solving and Decision Making

Most people, including many authors, do not realize that problem-solving and decision-making formulas are derived from "The Scientific Method." Even some of those claiming that "The Scientific Method" does not exist will offer formulas on problem solving and decision making. This situation is largely due to the lack of adequate research, development, discussion, and publicity about "The Scientific Method" that has occurred since Dr. Conant and Sir Popper expressed their negative views. To confirm the relationship of discovery, problem solving, and decision making, read the works of Nobel Laureate Herbert Simon, often called "The Father of Artificial Intelligence" (see quotations on Pages 8, 9, and 24).

So . . . how can "The Scientific Method" not exist?

There is a usual pattern to the method of how we refine, extend, and apply knowledge in all fields

Human thought is not a random operation. Thus, in almost any complex human activity that is repeated over and over, you can safely assume that there will be patterns to the activity. It is a pattern that many authors refer to as a method, when writing about how we refine and extend knowledge. An example of the "set of operations" to which Dewey refers is the list of 14 ingredients which comprise THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14). These could also be called guides, stages, processes, etc. and can be employed in a flexible order. Under these ingredients, we can combine thinking skills with creative, logical, and technical methods and processes to actually accomplish results.

So . . . how can "The Scientific Method" not exist?

Utilization of Thinking Skills: Low — High — Critical

Remember—a decision is just another kind of problem. The biggest use for thinking skills is problem and decision origination, prevention, solution, and challenge of solution (see Page 7).

So . . . how can "The Scientific Method" not exist?

Survey of how inventors work

Results of this survey of 710 inventors show that their methods of invention match SM-14 (see Page 13).

So . . . how can "The Scientific Method" not exist?

Proper interpretation of the word "method"

It is possible to claim the non-existence of "The Scientific Method" if you misunderstand or misinterpret the word method, as used in its name. As explained in the box at the top of this page, "The Scientific Method" is meant to mean a guide — not something that will, in itself, solve problems. This proper interpretation of "method" falsifies the opinion that "The Scientific Method" is only an "alleged method."

How can you say that "The Scientific Method" does not exist?

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THE HARD-TO-BELIEVE SITUATION CONCERNING THE EXISTENCE OF "THE SCIENTIFIC METHOD"

On the previous page I have explained how "The Scientific Method" must exist. Here is the story of why its existence has been denied, in spite of its great usefulness.

Until the 1950's, the teaching of "The Scientific Method" was generally accepted as a valid concept. However, beginning in 1947, Dr. James B. Conant, President of Harvard (1933-1953), and "one of the great teachers and scientists of our age,"[1] erroneously claimed[2] that "The Scientific Method" did not exist.[3] Sir Karl Popper, "widely acclaimed as the greatest philosopher of science,"[4] also claimed that there was no context of discovery and recommended his hypothetico-deductive system,[5] which is being challenged more and more.[6] It is a basic principle that great men are often wrong.[7] Their opinions in the field of social sciences should thus be viewed with more critical skepticism, regardless of their rating as an authority.[8]

The concept that "The Scientific Method" does not exist has practically become our National Policy.[9] Unfortunately, educational and professional organizations, dedicated educators and scientists, and other well-intended followers of the above-mentioned prestigious men, have reflected this erroneous concept into the grade school systems in the United States and England.[10] Most science textbooks have long devoted a few pages to "The Scientific Method" (some stopped), but with inadequate coverage and a variety of formulas. Also, "The Scientific Method" (or parts of it) is being taught under other names. This is confusing to everyone.

1. Publisher's front-page reference in *On Understanding Science*, Conant: 1951 (1959-8th printing).
2. Easley challenges Conant's views in "Philosophy and Education: Modern Readings," edited by Schleffer (1958 Edition).
3. *On Understanding Science*, Conant–1951 (1959-8th printing) and *Science and Common Sense*, Conant (1961).
4. *Nature of Science Booklet J, 1983 Science in Society Readers*, Heineman, Assn. for Science Education, England.
5. *The Logic of Scientific Discovery*, Popper (1959).
6. *Seeds of Discovery*, Beveridge (1980); *Scientific Discovery, Logic and Rationality*, ED: Nickles (1980); *Models of Discovery*, Simon (1977); *Patterns of Discovery*, Hansen (1972).
7. *The Art of Scientific Investigation*, Beveridge (1957); *Educational Research*, Mouly (1978).
8. *The Sources of a Science of Education*, Dewey (1929).
9. Why I believe that the concept that "The Scientific Method" does not exist has practically become our national policy:
   National Academy of Science: They deny the existence of "The Scientific Method" in their publication, *On Being a Scientist*. They have not included it in their (U.S. Dept. of Education-sponsored) "National Science Education Standards: July '93 Progress Report," except for parts of it under other names.
   American Association for Advancement of Science: In their SAPA program (started in 1960) they focused on eight basic processes of science instead of teaching "The Scientific Method." In their current program to reform science education, Project 2061, they still claim that "The Scientific Method" does not exist. These programs involve public funds.
   The National Science Foundation: Dr. Conant, in 1950, was a principal advocate before Congress in urging its formation. He served on its board and as advisor for many years. I could find no NSF-supported research regarding "The Scientific Method" nor its inclusion in any programs which they helped finance.
   U.S. Dept. of Education: They have supported no research about "The Scientific Method." The Dwight D. Eisenhower Mathematics and Science Education Program that they support is doing nothing on "The Scientific Method."
   U.S. Dept. of Labor: Not included in their training programs or plans.
   National Science Teachers Association: It is not included in their taxpayer-financed science reform program.
   Educational Testing Service: With a grant from Carnegie Corporation in 1958, they supported Dr. Conant's *A Study of the American High School."* In researching, I found no indication that their test calls for any knowledge of a formula for "The Scientific Method."
   The Association for Supervision and Curriculum Development: They do not cover "The Scientific Method" in their literature.
   Thinking Skills Programs: I've been unable to identify any which include "The Scientific Method," unless under another name.
   Other government agencies or private organizations with government grants (no room to list here): I did not find any that have done any research or promotion of "The Scientific Method."
   Harvard University: Its professors & schools have been very influential in our national educational policies. They have usually reflected Dr. Conant's views, as near as I can determine, except E. Bright Wilson in "An Introduction to Scientific Research."
10. Probably because of Sir Popper's influence, there is no reference to it in any of my English educational books.

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PHILOSOPHICAL OPPOSITION TO THE EXISTENCE OF "THE SCIENTIFIC METHOD"

There are philosophers, scientists, and others who have not favored "The Scientific Method" as it has been described and formulated over the years, largely on philosophical grounds. Keep in mind that these descriptions and formulas have not been as complete, nor as clearly detailed and explained, nor as close to actual practice as THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14.)

Justification
H-D System
Corroboration
Falsification
Philosophy of Science

Most other opposition usually falls into one of these groups:

(A) Followers of Sir Karl Popper's hypothetico-deductive system, which begins with the hypothesis.

(B) Those who claim that science is theory driven, and they, too, usually begin with the hypothesis.

(C) Those who do not believe in the usual definitions of induction and deduction.

Reasoning behind the above concepts is usually based on complicated, deep, intellectual, and/or philosophical thinking.

The big point I would like to make, which has been largely overlooked by these opponents of "The Scientific Method," is that:

A practical formula does not start with a hypothesis

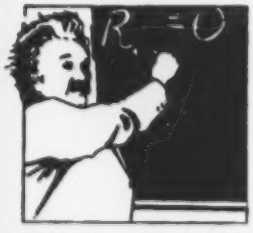
The formula presented for the Hypothetico-Deductive System usually is:

1) Hypothesis 2) Falsification 3) Theory

However, the literature on the art of scientific investigation contains many references to the "fact" that *seldom* does a researcher first arrive at a working hypothesis that survives falsification and becomes a theory.

George, in *The Scientist In Action* (1936), states, "the following statements by men of scientific genius are given to show that they all freely acknowledge that they spend a great deal of time and effort on ideas which they later reject."

Einstein's comment was, "I think and think, for months, for years, ninety-nine times the conclusion is false."



It is safe to assume, then, that an investigator who arrives at an initial hypothesis should consider it a tentative hypothesis. This then should be subject to:

SM-14 Ingredient #2—Is There A Problem?
SM-14 Ingredient #3—Goals and Planning
SM-14 Ingredient #4—Search, Explore & Gather the Evidence
SM-14 Ingredient #5—Generate Creative & Logical Alternative Solutions
SM-14 Ingredient #6—Evaluate the Evidence

Only then, if the idea or theory is still viable, do you have a working hypothesis for Ingredient #7—Make the Educated Guess (Hypothesis) . . . one that is worthy of the serious testing, experimenting, or thinking required by Ingredient #8—Challenge the Hypothesis (in the H-D system, this is the falsification stage).

Unwarranted or Misinterpretation of Views

Many in groups A, B, and C are debating and expounding their theories to fellow intellectuals without realizing that some educators, even as far down as those supervising curricula in grade schools, are interpreting their views to mean that a simple, practical, and flexible method for problem origination, prevention, solution and challenge of solution (such as SM-14) should not be taught. It is not practical to teach children that science is theory-driven and begins with a hypothesis. They need a simple, *complete* formula such as SM-14.

Those who oppose "The Scientific Method," because of the prevailing narrow view or the opinion of prestigious individuals and groups, have referred to it in the following manner:

The Alleged Scientific Method	No Specific Scientific Method
So-called Scientific Method	No Single Scientific Method
The Spurious Scientific Method	The Stereotype Scientific Method
No Scientific Method	Myth of Scientific Method

A CHALLENGE OF PROPOSED NATIONAL SCIENCE EDUCATION STANDARDS

CHALLENGE HYPOTHESIS

The National Research Council (NRC), the principal operating agency of the National Academy of Sciences, accepted a contract from the U.S. Department of Education to help develop National Science Education Standards.

In February 1993, the NRC issued *National Science Education Standards: An Enhanced Sampler*. This is a working paper and preliminary report subject to change. Unfortunately, it makes no reference to "The Scientific Method" or THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

This is a challenge to their continued denial of the existence of "The Scientific Method"!

THE "NATURE OF SCIENCE" VS. THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

Chart From NRC February 1993 Proposed Standards Report

VI Figure 6-1 NATURE OF SCIENCE	
Modes of Inquiry	Formulate questions
	Plan experiments
	Make systematic observations
	Interpret and analyze data
	Draw conclusions
	Communicate
	Understanding of Inquiry
Habits of Mind	Intellectual honesty
	Skepticism
	Tolerance of ambiguity
	Openness to new ideas
	Communication and sharing
Attitudes and Dispositions	Curiosity
	Reflection
	Pleasure in understanding
	Empowered to participate

VII APPLICATIONS OF SCIENCE	
Domain	Organizers
Decision Making	Formulate problem statement
	Identify dimensions of the issue
	Gather information
	Generate and evaluate alternative solutions
	Recommend a preferred solution
	Participate in decision making
	Understand decision making

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)
Ingredients of SM-14

Part I—Origination to the Hypothesis

1. CURIOUS OBSERVATION
2. IS THERE A PROBLEM?
3. GOALS AND PLANNING
4. SEARCH, EXPLORE & GATHER THE EVIDENCE
5. GENERATE CREATIVE & LOGICAL ALTERNATIVE SOLUTIONS
6. EVALUATE THE EVIDENCE
7. MAKE THE EDUCATED GUESS (HYPOTHESIS)

Part II—Challenge to Suspend Judgment

8. CHALLENGE THE HYPOTHESIS
9. REACH A CONCLUSION
10. SUSPEND JUDGMENT

Part III—Take Action

11. TAKE ACTION

Part IV—Supporting Ingredients

12. MOTIVATION & SENSITIVITY
13. PERSONAL ATTRIBUTES
14. THINKING SKILLS, METHODS & PROCESSES

SM-14 is the basic formula for decision making!

The Superiority of SM-14 Is Readily Apparent—
PREVENT A MULTI-BILLION DOLLAR ERROR!

In *On Being a Scientist* (1989), The National Academy of Science denies the existence of "The Scientific Method." From the above, you see that NRC is also following this over-forty-year-old erroneous and unfruitful concept. To be fair, their report *is* a preliminary one. However, their July 1993 Progress Report is still referring to "Habits of Mind," with no reference to "The Scientific Method" or THE GENERAL PATTERN OF THE SCIENTIFIC METHOD. In November 1992, numerous copies of SM-14 were sent to them. These were ignored, and the NRC continues on its same old wrong path! This has been a multi-billion dollar error for many years and must not be allowed to continue.

CHALLENGE OF NRC-PROPOSED SCIENCE STANDARDS *(continued)*

Why is "Modes of Inquiry" (a seldom-used term) being used?
Having claimed that "The Scientific Method" does not exist, the leaders of The National Committee on Science Education Standards have been forced to use other terms, such as "Modes of Inquiry," which are seldom used.

Science teachers and some students are already familiar with the term, "The Scientific Method."
Teachers are familiar with "The Scientific Method" because many science textbooks (past and present) have devoted some pages to it. Now, suddenly, it appears that they are going to be asked to ignore this in favor of a new "Modes of Inquiry" term, with a very poor breakdown of the ingredients, guides, or "Modes." This change is not creative or logical—just confusing and time-consuming for teachers, students, authors, and textbook publishers. The SM-14 formula is much closer to what teachers have taught in the past.

Why "Habits of Mind" and "Attitudes and Dispositions"— instead of "Personal Attributes"?
The term "Habits of Mind" has been used very little in literature (although Dr. Conant used it in *On Understanding Science*). It is not a term that is fully descriptive. How can you logically select five "Habits of Mind" and four "Attitudes and Dispositions" when there are numerous others involved in the process of inc[illegible], discovery, problem preventing, problem solving, and challenging of solution? "Personal Attributes" is mor[illegible] complete as it covers character traits, skills, values, attitudes, etc. Under Ingredient #13 on Page 29 of the Student Booklet is a good list compiled of some of the personal attributes helpful in using SM-14.

Why a separate formula for Decision Making?
There is really only one basic formula—SM-14. Compare *their* "organizers" to the ingredients or guides of SM-14. These "organizers" more closely relate to "The Scientific Method" and SM-14 than what they have listed for "Modes of Inquiry"! Nobel Laureate Herbert Simon reports, "*Scientific discovery is a form of problem solving, and decision-making processes are essentially the same as problem-solving processes.*"

Why such a burden on science teachers?
How can science teachers find adequate time to teach subject matter if the burden of teaching "Modes of Inquiry, Habits of Mind, Attitudes, and Decision Making" is placed on them alone? Since SM-14 is a general method for use in practically all subjects, all teachers would share in its teaching.

THE EASILY PREDICTED FAILURE OF PLANNED EDUCATIONAL STANDARDS

Many dedicated people are working on standards. I have reviewed many of the preliminary reports and have followed comments in the educational press during the course of my research on SM-14. These points make it easy to predict the failure of current, complex plans!

1. Too much subject matter. As reported in Education Week, each domain will be asking that more subject matter be taught than the school day will allow. One coordination meeting has already failed.
2. The erroneous concept that "The Scientific Method" does not exist is almost our national policy (see Page 38, Note #9). This alone will cause any proposed standards to become quickly obsolete.
3. The changes coming as a result of the Information Superhighway (see Page 12) are not being adequately taken into consideration.
4. Standards are being set, but little attention is being paid to the problem of how to motivate students to meet them.
5. *First, you need to standardize and coordinate* what must be taught across the curricula in all domains and in what grades. Some of these things are:

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14) or similar

Thinking Skills	Learning How to Learn
Personal Attributes	How to Use Information Technologies
The Arts	What Should Student Portfolios Include?

Writing across the curricula (important because of the fast growth of Internet)

Planners are not looking at the "big picture" and are proceeding too fast. This will result in a heavy, constantly changing burden on teachers and the ultimate failure of the standards setting movement.

WHAT ETHICS ARE INVOLVED IN "THE SCIENTIFIC METHOD" SITUATION?

Not feeling qualified at this time to express an opinion of the ethics involved, I will point out a few thoughts on the subject. Hopefully, SM-14 will quickly gain acceptance so that there will be no need for me to consider the matter further.

The scientific field has long used "The Scientific Method," peer review, and self-policing. Thus, they have experienced less misconduct than most other fields.

While researching, however, I came across many clippings on the current concerns and disputes regarding misconduct in research. It is a very complicated, ill-structured problem, involving many panels, universities, and government agencies.

In attempting to get corrective action concerning the erroneous and unfruitful concept that "The Scientific Method" does not exist, I have experienced gray areas that need study. Specifically, they are:

(1) Excessive reliance by people and organizations on authoritativeness, and an unwillingness to change when evidence is presented that the authoritative concept is erroneous. In such a situation, if it is a personal or small matter, this is of no public importance; but when large amounts of taxpayer funds are involved and it "does serious damage to the process of science", it *does* become important.

(2) What is the dividing line between loyalty to a person's school, agency, organization, associates, profession, personal advancement, and loyalty to process of science, country and society?

Dewey, in *The Sources of a Science of Education* (1929), made the following statement (which I felt was harsh and hesitated to use, as those people and organizations directly involved in "The Scientific Method" misunderstandings and controversies are dedicated, conscientious, and great contributors to America's progress). However, the quote does alert us to the dangers of authoritarianism.

"The existence of scientific method protects us also from a danger that attends the operations of men of unusual power; dangers of slavish imitation partisanship, and such jealous devotion to them and their work as to get in the way of further progress. Anybody can notice today that the effect of an original and powerful teacher is not all to the good. Those influenced by him often show a one-sided interest; they tend to form schools, and to become impervious to other problems and truths; they incline to swear by the words of their master and to go on repeating his thoughts after him, and often without the spirit and insight that originally made them significant. Observation also shows that these results happen oftenest [sic] in those subjects in which scientific method is least developed."

It is interesting to note that Dewey starts with *"The existence of scientific method protects us,"* for as I have explained, it has become practically our national policy that "The Scientific Method" does not exist. He ends with " . . . *happen oftenest in those subjects in which scientific method is least developed."* That is exactly what happened! "The Scientific Method" has been denied to exist and, thus, not adequately developed. So, scientific method was not applied to whether or not "The Scientific Method" really existed. A kind of ring-around-the-rosy effect.

The panels, agencies, universities, etc. concerned with ethics should consider the general principles involved in #1 and #2 above for future guidance of researchers, investigators, and organizations.

The study of ethics requires the use of SM-14—the method of inquiry!

CHAPTER VII
CONCLUSION

THE ECONOMIC CONSEQUENCES OF NOT TEACHING THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

Bulletin!
U.S. Dept. of Education says estimated national 1993-94 school year expenditures may amount to 493 billion dollars!

Early in my research of SM-14, I made a rough estimate that 10% of our school expenditures were being spent less effectively by not teaching "The Scientific Method."

What if, in the 1950's, those very influential people and organizations opposed to teaching "The Scientific Method" and life-centered, problem-solving education (see pages 15 and 38) had, instead, promoted these same things?

If this had occurred, their associates, followers, students, and members would have, for the last forty years or so, investigated and developed "The Scientific Method" extensively. It would have been taught across the curricula and radiated out to the entire commercial, scientific, political, and other fields.

We would have become a nation of more thorough, imaginative, and successful problem originators, preventers, solvers, and challengers of solutions.

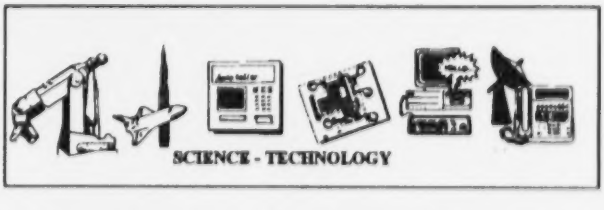
Thus, my estimate mentioned above of 10% may be low! There would have been yearly improvements in teaching "The Scientific Method" and its related thinking skills and the methods used under the ingredients. It is within reason that 50% of our educational dollars today would be spent more effectively. But whether it is

10% (49.3 BILLION) OR EVEN UP TO 50% (246.5 BILLION)

the sum is so large that it deserves your attention. Those directly in charge of spending school funds have a special responsibility to study the matter.

A More Visionary Estimate of the Economic Consequences of Not Teaching SM-14

Students enter the economy lacking the capacity to achieve their potential. Less knowledge is refined, extended, and applied. There is less creativity, innovation, entrepreneurship, and competitiveness. This all results in fewer inventions, ideas, products, technological advances, new businesses, and jobs originated. Our gross domestic product suffers by BILLIONS OF DOLLARS.



The teaching of "The Scientific Method" is of special importance in science, engineering, and technology.

Since Federal government agencies have not recognized the existence of "The Scientific Method" and utilized it in planning, evaluating and teaching science, it is not surprising that the following report has been issued.

A panel of the Federal Coordinating Council for Science, Engineering and Technology report of December 1993 states:

- Last year, the federal government spent **$2,200,000,000** on core Science Education Programs.
- Other programs not specifically targeted may be as much as **24 Billion Dollars**.
- This "potpourri of programs" has evolved with too little overall planning and inadequate evaluation.
- The USA remains at risk of losing its competitive edge.

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MY DILEMMA

While reading Dr. Crooks' article (see Page 36) in 1961, a *flash of illumination* hit me to write a booklet on "The Scientific Method" for my customers. But all I did was add a new folder to my idea files. What an opportunity to do a great social service . . . and it just slipped by! If I had been more curious, investigated, and taken action at that time, perhaps some of the billions of dollars that have been wasted (see Page 43), would have been spent more effectively after finding favorable support for "The Scientific Method" .

Progress is Basically Trial—Error—Success

There is no need for anyone to be embarrassed by their past opinion of "The Scientific Method." It is a complex, ill-structured, confusing problem and is insolvable if you get into deep philosophical debate rather than look for a practical working formula that the typical teacher can teach to the typical student.

The Dilemma in 1991-1992

As my research on "The Scientific Method" progressed, I dug deeper and discovered the situation described on Pages 38 and 39. This presented me with a dilemma . . . *what* to do and *how* to convince our country's dedicated and great leaders and organizations that their concept of the non-existence (and lack of teaching) of "The Scientific Method" is erroneous, unfruitful, and is causing billions of dollars of economic loss.

Idea & Research Report is Published in November 1992

Frankly, I rushed to produce a report that really required another year or so to more thoroughly prepare. It seemed best to publish at once—the need for it was urgent because of all the reform and standards efforts being planned and presented (according to Education Week, Chronicle of Higher Education, Science, NSTA publications, and others).

It was undoubtedly not as professional, readable, and convincing as it should have been . . . although the message and a good slice of the "meat" were there. Beginning in November 1992:

- ✔ more than 500 personal letters and booklets were sent to leading educators, scientists, government officials, professional organizations, media, etc.; and
- ✔ a bulk mailing of another 7,000 copies was mailed to similar audiences.

A Greater Dilemma in 1993-1994

Despite the distribution mentioned above, the report accomplished little. No one "picked up the ball" and started a movement to correct this tragic and unbelievable situation.

A researcher should, however, develop a passion for his problem; and that is just what happened. After seeing the big picture on the tragic situation that befell "The Scientific Method," I felt a moral, ethical, and social responsibility to ensure that SM-14 (or similar) quickly gained acceptance. To be this agent of change is unpleasant, difficult, and expensive.

Indulging in some self-criticism and putting aside plans to research discovery and creativity, I decided to expand my research and write this second editon, which would be easier to read and digest and would contain more convincing evidence.

It seemed feasible to pinpoint responsibilities, since our country's need for action is more urgent now than ever before. See Pages 40, 41, and 43 for an illustration of this urgency. It distresses me to do this, as the real need and objective should be to forget why the situation occurred and to get on with teaching SM-14 (or similar).

MY CONCLUSION IS A CHALLENGE!

If it weren't for the continuing dilemma of how to correct the difficult situation on "The Scientific Method," this page would close this report with favorable conclusions about SM-14 itself, to gain acceptance for its use.

An important observation made during researching "The Scientific Method" was that of the failure (during the last 35 years) of anyone to follow up and investigate Dr. Easley's 1958 scholarly report (see Page 38, Item #2).

In spite of considerable effort and expense since 1992, the same thing has happened to my Idea & Research Report issued in November 1992.

These events have convinced me that the "invisible barriers" that have been raised (usually unknowingly) against acceptance of "The Scientific Method" are so old, so well-entrenched, and so unyielding that SM-14 (or similar) will not gain acceptance now, when it is so urgently needed, unless the people and organizations that "erected" these barriers "tear" them down themselves.

There is reluctance (for various reasons) to challenge those who have "erected these barriers." This reluctance is so great and widespread that normal publicity, discussion, and debate which would lead to progress has not happened. Thus, serious damage to the process of science is occurring.

The admiration that scientists, educators, and others have for such truly great men as Dr. Conant and Sir Popper, as well as for Harvard University, is admirable and deserved. However, I sense a resentment on the part of the educational and scientific communities for this challenge of their concepts. Robinson & Kirk, in *Introduction to Psychology* (1936) state: "When the authority of one man's teachings becomes raised to such a point, sound reasoning upon the subject of his teachings becomes confronted with a definite barrier." This report shows that there is far more evidence to substantiate and support the existence of "The Scientific Method" than there is to disprove its existence.

In this era of change, we cannot depend upon authoritative opinions and allow an erroneous and unfruitful concept to retard our education reform efforts. The United States must stay competitive. We must *prudently* spend taxpayer dollars which are in short supply. This more detailed, revised edition of my Idea & Research Report presents more convincing support for SM-14. It is a matter of great national importance! Therefore . . .

In the spirit of science, this friendly, public challenge below is issued to:

Harvard University

Any great university that is a leader is not always going to be correct. As a result of the research presented here, my opinion is that Harvard (among others) is a major reason for the spread of the erroneous and unfruitful concept that "The Scientific Method" is only "an alleged method."

If this is so, it would appear that they have a special responsibility. Also, because of their great influence and leadership, it presents an opportunity for them to help America properly utilize THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

This challenge is also issued to the following, for reasons listed under Note #9 on Page 38:

National Academy of Sciences
American Association for the Advancement of Science
The National Science Foundation
U.S. Department of Education & U.S. Department of Labor
National Science Teachers Association
The Association for Supervision and Curriculum Development
Educational Testing Service

It would also help if other great institutions (which have taken similar positions) would appoint panels

My Friendly, Public Challenge

Each institution should appoint a panel to study this research report and other material on "The Scientific Method." In the course of doing so, analyze the need to properly define "The Scientific Method" in order to eliminate misunderstandings and misconceptions. Panel members are more than welcome to use my extensive library on "The Scientific Method" (in Fort Lauderdale).

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PARTICIPATE IN PROJECT KNOWLEDGE '95

Increase your sales, profits, operation efficiencies; and better achieve your goals. Correct a situation causing serious harm to America's standings in global competition.

What is this situation that requires your participation?

- Over the centuries, a basic method evolved by which we refine, extend, and apply knowledge. This is usually accomplished through problem origination, prevention, solution, and challenge of solution.
- For the last forty years or so, an authoritative but erroneous and unfruitful concept (not supported by research) has largely prevailed — that this method was only an "alleged one" or did not exist at all.
- As a result, several generations of students have received an inadequate, if any, education in the method. This has resulted in the waste of billions of taxpayer school dollars—not to mention human potential. Employers, in most recent school reform requests, have been asking for job applicants with better training in problem solving, thinking skills, and creativity.
- Because of current efforts and expenditures on school reforms, there is an urgent need to standardize on this method, but there is a reluctance to teach it. *Thus, your participation is needed!*
- This method is called by many names, but "The Scientific Method" is most frequently used. It is not just a method for scientists, though. It is a general method, suitable for use by everyone. A more descriptive name is THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14).

Some specific advantages for your participation in PROJECT KNOWLEDGE '95:

PROFIT-MAKING REASONS

- *You will gain knowledge of SM-14 and how to use it to substantially contribute to your own organization's progress by:*
  - ✓ Better Scientific Management
  - ✓ Meeting competition
  - ✓ Better utilizing information technologies
  - ✓ Improved employee training
  - ✓ Producing more ideas and innovations
  - ✓ More efficient problem solving
  - ✓ Meeting your customers' needs
  - ✓ Better employee personal attributes
- *In the course of performing a public service, you will soon receive more qualified employees.*

PUBLIC SERVICE

- *Your basic goal of improving human welfare will be advanced, as SM-14 will:*
  - ✓ Greatly improve education
  - ✓ Improve our nation's prosperity and health
  - ✓ Substantially aid science literacy
  - ✓ Greatly increase number of jobs available
  - ✓ Aid minorities to achieve more
  - ✓ Increase creativity and innovation
  - ✓ Better settle environmental issues
- *Service to the members of trade or professional organizations:*
  - ✓ Evaluate important situations
  - ✓ Provide a method to increase earnings and promote advancement

HOW TO PARTICIPATE

Participants should appoint an individual or committee to study and challenge the information in the booklets listed below (and, of course, challenge the position of those who are not using "The Scientific Method"). Recommendations should then be made accordingly. A reference list for other sources of information will be furnished on request.

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

Edmund's Idea & Research Report on THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

- Cost to participants: No dues or fees
- Initial sponsor: Norman W. Edmund, retired founder of Edmund Scientific Company
- Prices: To aid in the cost of this project, please order booklets at the prices indicated on the regular price list. However, there is an alternate *special offer to participants:* Order the two booklets mentioned above (regular cost $6PP) and more details on **Project Knowledge '95** for a total non-profit cost of $4PP (First Class Mail). Lower prices on quantities shipped UPS (see price list or fax for information).

Norman W. Edmund • 407 NE 3rd Ave., Ft. Lauderdale, FL 33301 • 305/525-7327, Fax 305/525-7459

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GENERAL INFORMATION AND PRICING
SM-14 Student Booklet & Edmund's Idea and Research Report

HOW TO ORDER: Send a check, purchase order, or money order to: NORMAN W. EDMUND
407 NE 3rd Ave • Ft. Lauderdale, FL 33301-3233 • Telephone 305/525-7327 • Fax 305/525-7459

Description	Quantity	Student Booklet (5½x8½)	Edmund's Idea & Research Report (8½x11)	Combination Package
Booklets	1-2	$3.00/ea	$5.00/ea	$6.00/set
FOB	3-4	$2.00/ea	$3.60/ea	$4.50/set
Delivered	5-9	$1.75/ea	$2.50/ea	$3.50/set
First Class Mail	10-24	$1.25/ea	$2.00/ea	$2.75/set

Florida residents include appropriate sales tax. Above orders are postage paid, via first class mail.
If you would like to receive information on future publications, please write and let me know. Purchasers will automatically be added to our mailing list. Camera-ready stats are available. Call for further information and pricing.

Student Booklet Collector's edition (1st ED, 1992). Hardbound copy, $14.95ea pp. Autographed copy for those wishing to support my projects, $25.00ea pp. I encourage businesses, foundations, schools, individuals, and government agencies to purchase, in bulk, for free distribution to customers, associates, and students. Note discounted bulk pricing.

Description	Quantity	Student Booklet	Idea & Research Report
Booklets	25-999	$0.85/ea	$1.35/ea
Bulk Packed	1000-4999	$0.60/ea	$0.80/ea
FOB Factory	5000-9999	$0.50/ea	$0.60/ea

Mailing services are available. Call or write to Gail Schuster for information and pricing.

Large Quantity Users: Special pricing on orders over 10,000. Your own custom-printed booklets, replaced with variable pages and/or different paper, are available.

LIBERAL FREE USAGE OF COPYRIGHT: This project was undertaken mainly as a public service. My basic objective is to gain acceptance for SM-14. Write or fax your intended use and for details on free use of material in the booklets.

YOUR HELP IS NEEDED TO GAIN ACCEPTANCE FOR THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

- Tell your family, friends, associates, and others about SM-14. Give copies to your employees.
- Purchase of the booklets helps me do more to spread the word about SM-14.
- Help is needed to finance mailings of free copies to educators, teachers, students, etc.
- Have your organization participate in Project Knowledge '95 or get a group together to participate.
- Write to those organizations listed as not believing in or supporting the use of "The Scientific Method" and ask them to review and evaluate SM-14.
- Ask your legislators to investigate SM-14 and what it can do for our schools and country.
- Encourage the media to run stories on SM-14. Cite in any articles that you write.
- On a local level, call teachers' and school officials' attention to SM-14.
- Encourage your state's Department of Education to review SM-14.
- Teach SM-14 and/or use as auxiliary material in your courses, training classes, etc.
- Discuss SM-14 at professional or other meetings.
- Help your children/grandchildren by giving them copies of the Student Booklet.
- Foundations and organizations are needed to promote acceptance of SM-14.

Thank you for reading this report . . .

Norman W. Edmund

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THE GOLDEN FORMULA FOR THE GOLDEN AGE OF KNOWLEDGE

THE GENERAL PATTERN OF THE SCIENTIFIC METHOD

SM-14

HAS THESE OUTSTANDING ADVANTAGES OVER OTHER FORMULAS FOR
"THE SCIENTIFIC METHOD" – PROBLEM SOLVING – DECISION MAKING

☑ IT IS A COMPLETE METHOD OR GUIDE, COVERING ALL PHASES OF PROBLEM ORIGINATION–SOLUTION–CHALLENGE OF SOLUTION–ACTION
(The basic method by which we refine, extend, and apply knowledge.)

☑ IT IS A GENERAL METHOD . . . NOT JUST A METHOD FOR SCIENTISTS
THIS STANDARD METHOD WILL REPLACE HUNDREDS OF OTHER FORMULAS

☑ "METHOD" AS USED IN THE TITLE MEANS "GUIDE"
IT IS NOT A "METHOD" WHICH IN ITSELF WILL ACCOMPLISH RESULTS

☑ TOTAL FLEXIBILITY IN USE OF THE GUIDES
THESE ARE INGREDIENTS, NOT RULES OR STEPS

☑ THE TERMINOLOGY IS SIMPLE, CLEAR AND CONCISE
IT IS EASY TO TEACH AND REMEMBER

READ HOW SM-14 WILL BE OF GREAT VALUE

For creating jobs ..... Page 10
To disadvantaged students ..... Page 19
In teaching science and technology ..... Page 11
For environmental problems ..... Page 20
For innovation and creativity ..... Page 14
For scientific management ..... Page 22
In your personal life ..... Page 18
In teaching thinking skills ..... Page 29

For a full description of SM-14, read the Student Booklet
THE GENERAL PATTERN OF THE SCIENTIFIC METHOD (SM-14)

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